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Observations on Himalayan Tahr (*Hemitragus jemlahicus*)

BY

GEORGE B. SCHALLER

(*With two plates and a text-figure*)

A small population of Himalayan tahr was observed on 20 days in eastern Nepal. Tahr used several vegetation types, ranging from broadleaved forest to alpine meadows between altitudes of 2500 and 4400 m, but their favoured habitat was grass-covered cliffs with patches of forest. Adult males outnumbered adult females by a ratio of 2 : 1 ; there were 56 young and 44 yearlings to 100 adult females. Tahr herds seemed to confine themselves to definite ranges. All members of herds were seldom together but congregated into unstable groups of varying sizes. Average group size was 6·5. Some adult males were with the females at the time of the study, some were solitary, and the rest were in small male groups. Tahr were most active before 0900 and after 1330 hours. Their principal food was grass, supplemented with browse. Courtship displays are described. Several indirect and direct forms of threat are used by tahr and these are described and quantified. Comparisons with Nilgiri tahr are drawn whenever possible. In their physical appearance, tahr represent a link between rupicaprids and the true goats of the genus *Capra*. This study shows that tahr also resemble both rupicaprids and true goats in their forms of aggression.

Himalayan tahr (*Hemitragus jemlahicus* H. Smith 1826) were successfully introduced into New Zealand in 1904. Anderson and Henderson (1961) published notes on the biology of these animals, and Caughley (1966, 1970, 1971) discussed their population dynamics in detail. Information on Himalayan tahr in their natural habitat consists only of general comments and hunting accounts (Burrard 1925 ; Stockley 1928), and even a description of the species' behavioural repertoire is unavailable

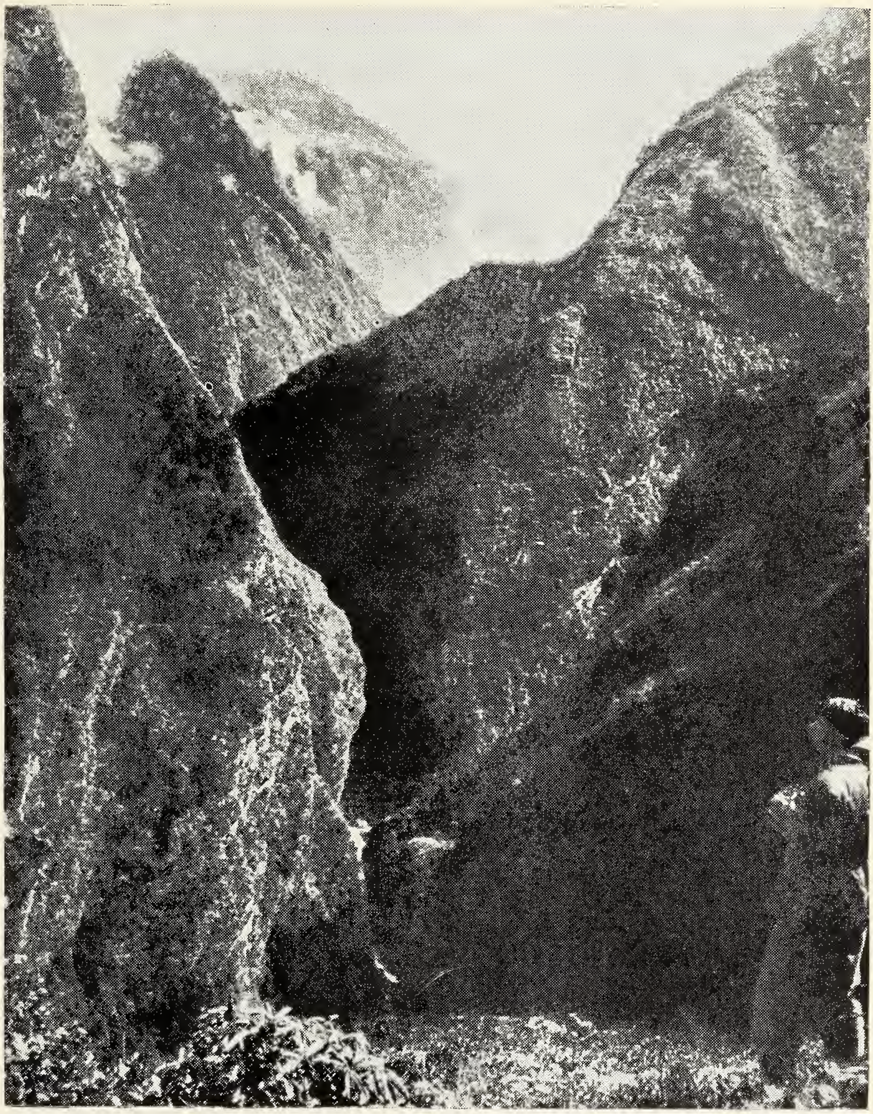
Between February 25 and April 5, 1972, I observed tahr on 20 days in and around the Kang Chu valley (also known as the Zom valley) of eastern Nepal. While my contact with the animals was limited to 80 hours of observation, the data contribute to the knowledge of the species and provide a basis for comparing the behaviour of Himalayan tahr with that of Nilgiri tahr (*Hemitragus hylocrius*).

The Kang Chu has its source in the Tibet province of China but soon crosses the border and flows southward through Nepalese territory for about 15 km before joining the Bhota Kosi river a stretch during which it descends from an altitude of 4000 m to 2500 m. A mountain range with peaks exceeding a height of 6000 m borders the valley on each side. At its confluence with the Kang Chu, the Bhota Kosi enters a canyon whose sheer cliffs rise 1000 m or more. After about 2 km the valley broadens, and soon after that, near the village of Lamobager, the river tumbles to lower altitudes. Tahr frequent most cliffs along the lower Kang Chu, the upper Bhota Kosi, and the adjoining Rongshar and Chyadu river valleys. I found tahr fairly abundant and observable only on the cliff that flanks the western bank of the Bhota Kosi between the mouths of the Kang Chu and Chyadu valleys (86° 14′ E., 27° 57′ N.). By climbing the cliff on the opposite side, I was able to observe tahr across the narrow canyon with a 20-power scope (Plate 1).

HABITAT

Himalayan tahr are found from the Jhelum river in the Pir Panjal Range of Kashmir eastward along the southern flanks of the Himalayas to about central Bhutan (Burrard 1925). Animals may occur from altitudes of as low as 1550 m in winter (Stockley 1928) to as high as 5300 m in summer (Caughley 1969). In the Kang Chu area, the species was observed between about 2500 and 4400 m, a range of altitudes which includes several vegetation types. The valleys and lower slopes up to an altitude of around 3000 m (the exact limit depending on degree of slope and exposure) are covered with a montane 'evergreen broadleaved forest' (Schweinfurth 1957). Although *Quercus* spp., *Buxus wallichiana*, and other trees may form almost monotypic stands, the forest usually consists of a variety of trees among which the genera *Rhododendron*, *Magnolia*, *Acer*, *Alnus* and *Tsuga* are prominent. Except for a few tall stands with a closed canopy beneath which there is little undergrowth, the trees are seldom more than 20 m high and the understory of saplings, shrubs, vines, and bamboo (*Arundinaria*) may be dense. Boulders often litter the floor and occasional cliffs break the continuity of the forest. Above the broadleaved forest is a belt of conifers and rhododendrons, with particularly fine stands growing on gradual terrain with a northern on north-eastern exposure. Fir (*Abies*) is the dominant

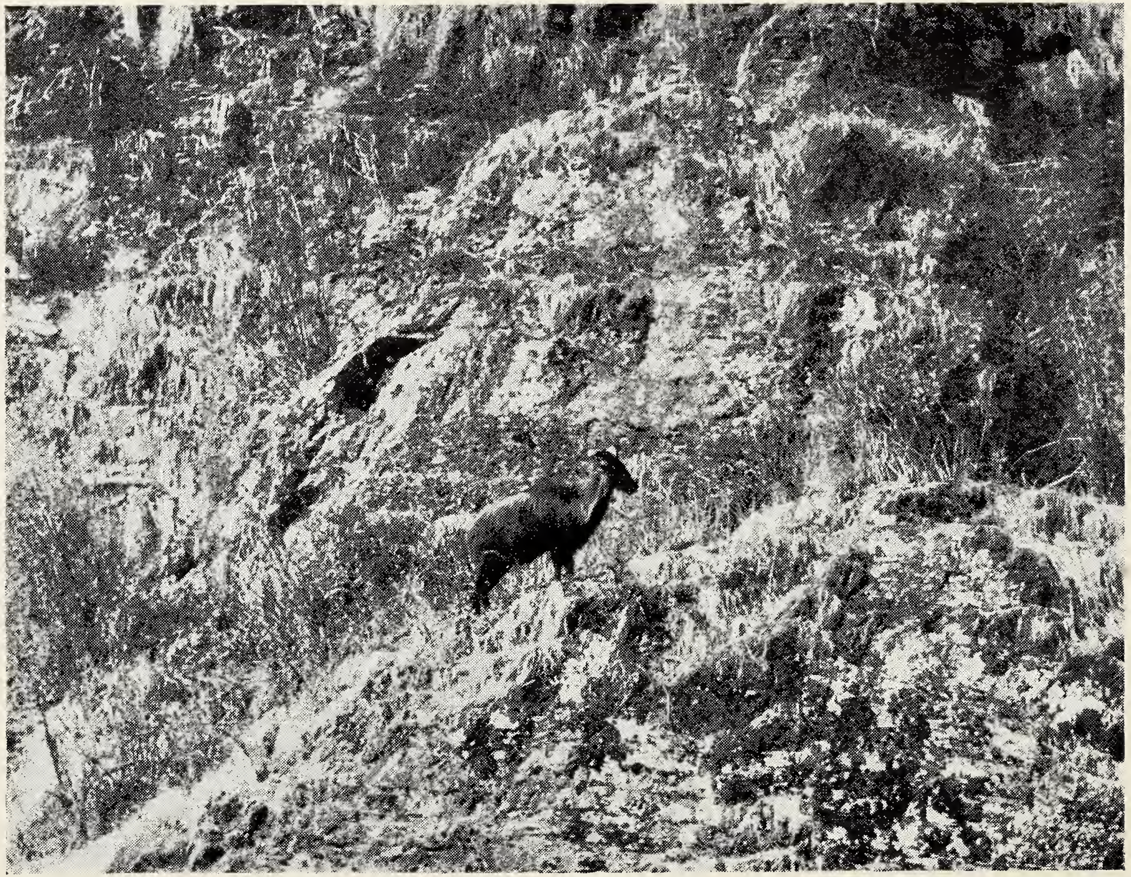
Schaller : Himalayan Tahr



The main tahr study area along the upper Bhota Kosi River, Nepal.

(Photo : George B. Schaller)

Schaller : Himalayan Tahr



A young adult male (class II) tahr on a typical ledge covered with grass and some shrubs.

(*Photo : George B. Schaller*)

tree, and beneath it is a sparse understory of *Rhododendron* and *Betula*. At an altitude of about 3600 m the fir gives way to a stunted transitional zone of rhododendron, birch, willow and juniper, and it soon grades into the alpine vegetation of grasses, forbs, and mat-like shrubs. The line of permanent snow is at around 5600 m. Another habitat, one not recognized as distinct by Schweinfurth (1957), is found on cliffs, especially steep ones with a somewhat southern exposure. The faces of most cliffs are broken by many ledges and platforms which support much grass and occasional patches of shrub, bamboo, and broadleaved forest. With some cliffs rising for over 1000 m from the valley floor, this grassy habitat may grade into the alpine vegetation without an intervening forest belt.

The literature contains conflicting opinions about habitat preferences of tahr, although all authors agree that the animal ' revels in the steepest precipices ' (Burrard 1925). Kinloch (1892). Burrard (1925) and others felt that tahr remain in forests and dense thickets, never ascending above timberline. Lydekker (1924), too, labeled them as ' essentially forest animals, ' but he noted that they may wander into the open. Prater (1965) held a similar view, and added that animals are never found outside thickets 'after the sun has well-risen.' In contrast, Caughley (1969), who observed tahr in central Nepal rather than in India as did the previous authors, stated that ' the habitat of this species is the subalpine zone between 3900 m and 5300 m.' I found tahr to be considerably more adaptable than these statements would indicate. Tahr frequented all habitats in my study area, although the conifer-rhododendron belt appeared to be used mainly in transit, perhaps because there was little food near ground level, especially in winter when snow was deep. The animals certainly were not adverse to open terrain. Old sign in the form of droppings and rest sites indicated that tahr spent much time above timberline during summer and autumn, and groups often remained on open cliffs throughout the day. In fact, tahr in New Zealand have adapted to tree-less terrain (Caughley 1970). The favoured habitat of tahr in the Kang Chu area, at least from February to April, was the grassy cliffs broken by small stands of forest and bamboo below an altitude of 3500 m. I suspect that the animals spent the winter there too, for the oaks and other evergreen trees provide forage as well as protection from bad weather. Furthermore, grass on cliffs is often accessible, the snow removed by wind and sun, while forests and alpine meadows remain deeply covered.

DESCRIPTION OF ANIMALS

Tahr differ from goats of the genus *Capra* in that both sexes lack a beard and have short, laterally compressed horns which curve sharply backward. They resemble typical goats in their strong body odour and in the absence of pre-orbital, inguinal, and pedal glands on the forefeet (Lydekker 1924). Male and female Himalayan tahr differ considerably in size and appearance, as do the sexes among most members of the tribe Caprini. I recognized several age and sex classes. The ages of subadults and of adult males were estimated on the basis of body size, pelage length, and other physical characteristics. It was sometimes possible to count growth rings on the horns of males. As Caughley (1965) has shown, one growth ring is laid down every winter of life after the first. The approximate ages are given as they were at the time of study.

Adult male (*Class III*), almost 5 or 6 years old and older. Males are handsome creatures with narrow, black faces and stocky bodies, the forequarters being particularly powerful. Their shoulder height ranges from 91 to 102 cm and their weight is around 90 kg (Lydekker 1924). Anderson and Henderson (1961) give similar figures for height of New Zealand tahr, but they estimate that some animals may weigh as much as 150 kg. The dark horns have a sharp keel in front. ' A well-developed set of bull tahr (*sic*) horns will measure 12-15 inches in length....and 8½-9 inches in circumference around the base ' (Anderson and Henderson 1961). A male's most conspicuous feature is his ruff and mantle of flowing hair which drape from his neck, shoulders, and chest down to his knees and from his back and rump down to his flanks and thighs. The neck ruff is light brown in colour, as is the hair on each side of the dark mid-dorsal streak. There is also a light eye-ring and chin. The hair surrounding the anus is rusty in colour. The rest of the body is covered with a deep coppery brown to blackish pelage.

Young adult male (*Class II*), almost 4 years to perhaps 5 years old. Males of this age class resemble those in class III in size and in the presence of the shaggy ruff on neck and shoulders, but they are not as robust and the mantle of hair along the back is fairly short (Plate 2).

Subadult male (*Class I*), almost 3 years old. Class I males are only as large as or slightly larger than adult females. Their pelage is not as dark as that of adult males, and their horns are smooth and yellowish rather than corrugated and dark. Although a neck ruff is conspicuous, males of this class lack a mantle along the back.

Yearling male, almost 2 years old. Yearling males are smaller than adult females. In colour they resemble females, but they have a noticeable ruff.

Female, with a maximum weight of 36 kg (Anderson and Henderson 1961), adult females are considerably smaller than adult males. Their neck is yellowish brown in colour, except for a dark stripe along each side and along the mid-dorsal line. A light streak runs along each side of the back from the shoulders to the rump ; the sides of the muzzle also show a pale line. The abdomen is whitish. The rest of the pelage is dark brown. Some females have a small ruff but most have just a slight crest of hair on the back of the neck. The horns of females resemble those of subadult males in appearance, except that they are somewhat shorter and more slender. Yearling females are of the same size as yearling males, the most conspicuous difference between the two being that females lack a ruff.

Young, almost one year old. Young resemble yearlings, but they are considerably smaller, and, in the case of males, lack a ruff. Most young still followed and rested besides their mother even though they were weaned, judging by the fact that females discouraged occasional suckling attempts by stepping aside.

POPULATION DYNAMICS

Tahr were difficult to census because they were often out of sight in thickets. Although I often scanned the slopes of the Kang Chu Rongshar, and upper Bhota Kosi valleys, tahr were seldom seen, suggesting that they were scarce there. But there was one cliff along the Bhota Kosi, a huge pyramid-shaped one over 1 km long at the base and some 1000 m high, on whose face I readily found tahr. At least 45 tahr frequented this cliff, and, assuming a few were overlooked, the total was probably around 50.

TABLE 1

TAHR POPULATION STRUCTURE

	A Structure based on known number of different tahr on study cliff		B Structure based on all animals tallied in study area	
	No.	%	No.	%
Male III	2	4·4	14	5·7
Male II	3	6·7	14	5·7
Male I	4	8·9	17	6·9
Yearl. male	4	8·9	28	11·4
Adult female	18	40·0	93	37·8
Yearl. female	4	8·9	18	7·3
Young	10	22·2	62	25·2
Total	45	100·0	246	100·0

Table 1A shows the population structure of the 45 tahr on the study cliff. Since females limit themselves to distinct home ranges whereas adult males tend to wander widely (Caughley 1966), the percentages are probably biased in favour of the former. Another way to analyze structure is to add up all tahr seen daily in the study area (Table 1B). This, however, skews data in favour of those animals which are met repeatedly. Nevertheless, the percentages derived by the two methods show close agreement. Adult females outnumbered classes I to III males by a ratio of about 2:1, in contrast to New Zealand tahr which seem to have a 1:1 ratio (Anderson and Henderson 1961). Fetuses examined by Caughley (1966) in New Zealand showed no disparate ratio. Male and female yearlings were represented equally in my study population. These facts suggest that males are perhaps not quite fully represented in the sample, solitary individuals being difficult to find, and that they may have a higher death rate than females, but I lack evidence on either point. Nilgiri tahr and Kashmir markhor (*Capra falconeri cashmiriensis*) also have a disparate sex ratio favouring females (Schaller 1970 ; Schaller and Mirza 1971).

Anderson and Henderson (1961) noted that some New Zealand tahr conceived as yearlings at the age of 18 months. The yearlings in my study population had slim abdomens, in contrast to the extended ones of adults, indicating that they were probably not pregnant. Himalayan tahr, in their natural habitat appear to have their first young at the age of 3 years. Males do not reach sexual maturtiy until at least 2 years of age, the testes of yearlings failing in most instances to increase in size and to produce sperm during the rut (Caughley 1971).

There was one pair of twins among 158 embryos examined by Caughley (1971) in New Zealand, and none in 66 examined by Rammell (1964). The 180 births in the New York Zoological Garden included one set of twins (Crandall 1964). Zuckerman (1953) reported on 115 births in the London Zoo and noted one pair of twins for every 12 births. Thus, single births seem to be the rule. Females in the Kang Chu had one young at heel, except for one female which had two. Three young were with a female on several occasions, but these were temporary associations, the extra young joining other females later. Some 22% of the study population consisted of young, or 56 young to 100 adult females. Taking into account that several adult females had not yet had their first young and that an occasional female was perhaps barren, the figures suggest that around a third of the young had died between birth and the age of 8 to 9 months. Yearlings comprised 18% of the population, or 44 yearlings to 100 adult females, a good increment. With the tahr seemingly healthy and reproduction good, the population should be increasing unless an excessive number of adults die. I have no observations on causes of death. Some animals probably have accidents, and a few are no doubt killed by leopard (*Panthera pardus*), and, in the event that they straggle to the headwaters of the Kang Chu, by snow leopard (*Panthera uncia*). Meat hunters visit the area every summer, according to the local Tibetans, and it is perhaps not coincidental that I found the densest tahr population on a cliff that is almost inaccessible to man.

HERD DYNAMICS

The tahr population on the study cliff was divided into two herds separated by a strip of forest, one using the northern portion, the other the southern. The females and young associated only with members of their respective herd, judging by the fact that several animals which I recognized individually were always on their usual part of the cliff, but some males may have wandered from one herd to the other. The northern herd contained at least 10 females and 5 young, the southern herd 12 females and 5 young. Several males of varying ages were with or near each herd. A third herd, seen only once on a slope opposite the study cliff, contained 9 individuals of which 3 were males. Members of a herd were seldom all together, being instead scattered in small groups which often joined and separated in various combinations in the course of a day. One dawn, for example, I spotted a group of 11 tahr, but by mid-morning it had split into groups of 4 and 7 which moved in opposite directions. A total of 36 groups (excluding groups composed solely of males) were classified during the study, a group being defined as two or more individuals separated by at least 200 m of terrain from others. Groups ranged in size from 2 to 23 with an average of 6·5, as compared with at least 22 members in each of the two study herds.

The basic social unit consisted of a female and her young. Such pairs roamed at times far from other herd members. Another common association included two or three females, a young or two, and often a yearling of either sex. Table 2 shows the composition of 3 large groups.

TABLE 2

THE COMPOSITION OF THE LARGEST GROUP IN EACH OF 3 HERDS SEEN DURING THE STUDY

Name of Herd	Male III	Male II	Male I	Yearl. Male	Adult Female	Yearl. Female	Young	Total
North	2	2	2	2	8	2	5	23
South	0	1	1	2	4	2	2	12
East	1	0	1	1	3	1	2	9

Nine out of 12 groups with 7 or more tahr contained at least one subadult or adult male. But, as is the case in many ungulate societies, contact between adult males and females outside the period of rut tends to be transitory. Males which were in a group in the morning had often left it by evening, going off singly and in twos or threes, perhaps to rejoin casually the following day. Even when such males were with a group, they often congregated at the periphery. For example, in the group of 23 (see Table 2), two class III males and one class II male fed and rested side by side near the others for several hours before leaving together. Eighteen per cent of the subadult and adult males I tallied were solitary or in twos. Stockley (1928) once observed a group of 6 male tahr and another time 24 of them together. Yearling males were usually with the females. However, on three occasions, a yearling was seen in the company of a subadult male far from any other group. Later in the season, contact between males and females may become even more tenuous. Caughley (1966), for instance, wrote that 'during the summer tahr range in three main kinds of groups : one consists of females, juveniles and kids, a second consists of young males and the third of mature males.' The males are said to join the females again in September prior to the rut (Burrard 1925).

The herd structure of Himalayan tahr resembled that of Nilgiri tahr (see Schaller 1970). In both species the herds tended to split into temporary groups and males had progressively less contact with the females after the rut. But there were two differences, at least in the populations I studied. The average group size of Himalayan tahr was 6·5 as compared to 23 in Nilgiri tahr. The latter species does most of its feeding on rolling grassland near cliffs. Such a habitat provides a concentrated and abundant food source, and this may well promote cohesiveness among herd members. In contrast, Himalayan tahr spend much of their time along narrow ledges where large groups would be at a disadvantage. Though average group size differs in the two species, average herd size possibly does not, but data on this point are lacking. Another difference between the species may be in the age at which males become solitary or join male herds. Some yearling Himalayan tahr, not quite 2 years old, had temporarily left the females, whereas Nilgiri tahr were not observed to join male herds until at least 3 years of age.

GENERAL BEHAVIOUR

Tahr spent most of the day feeding or resting, usually remaining several hours, or even a day or two, on a small section of the cliff. Only on a few occasions did a group move steadily for several hundred metres to another site. Sometimes animals travelled from a shady area until they reached one in the sun, and once they hurried away after boulders had crashed past them. At other times no reason for their movement was apparent. To obtain information about the activity pattern of tahr, I recorded the number of active animals every 5 minutes. The 6 points in each half-hour period were combined and expressed in per cent of animals active in the Figure which is based on 7146 activity observations between 0635 and 1730 hours. Tahr foraged and moved during all daylight hours, but there were peaks of activity before 0900 and after

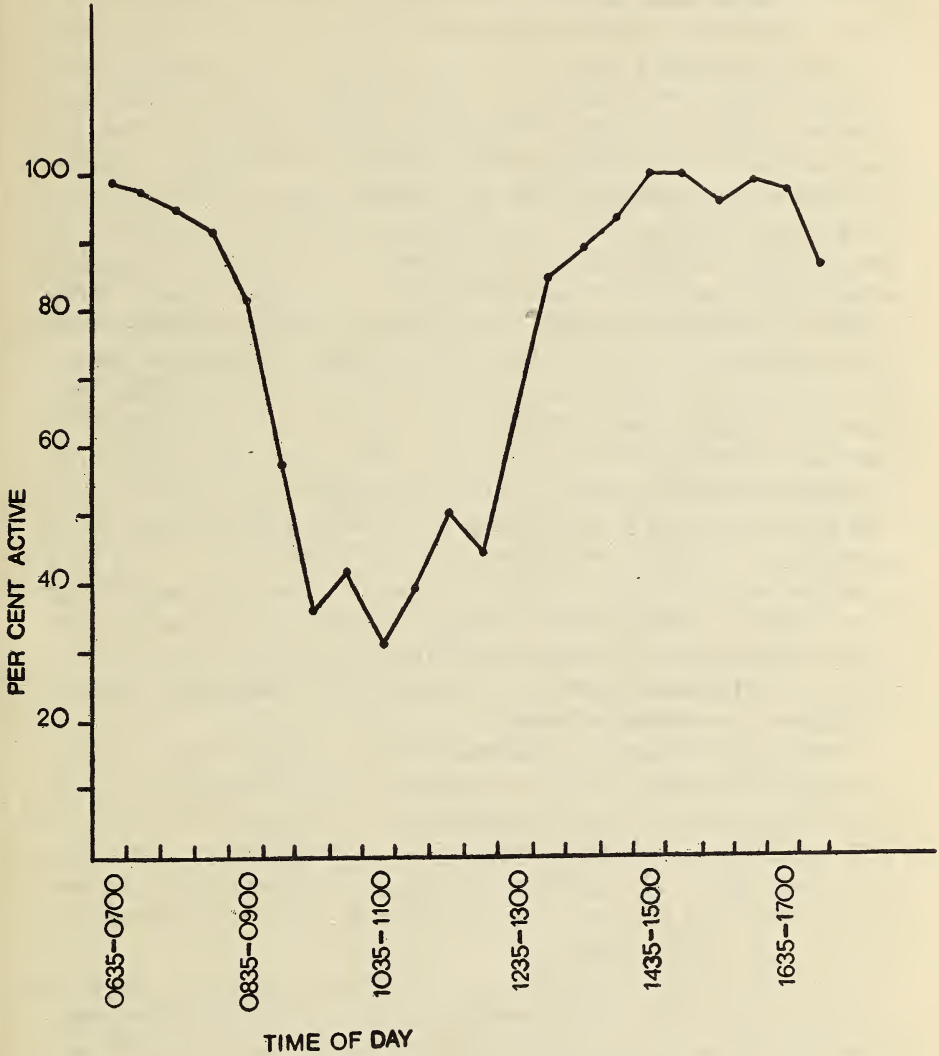


FIGURE. Per cent of tahr active at various times of day, 0635 to 1730 hours.

1330 hours. Although tahr were, in general, least active from mid-morning to early afternoon, the same groups sometimes varied considerably in their foraging pattern from day to day, often without obvious cause. Weather, however, may affect activity. On several occasions a group rested while the sky was clear, then began to forage as soon as it became cloudy. Groups seldom reclined for more than an hour or two without at least one member feeding, and, in large groups, there was usually some activity from dawn to dusk.

Tahr had a limited selection of food plants available at the end of the winter. Oak leaves were eaten whenever a group was in a forest patch. To reach low-hanging leaves, an animal may rear up on its hindlegs and bend and hold down a branch with one or both forelegs while browsing rapidly. Once a subadult male leaped 2 m into the fork of a tree, behaviour common in foraging Kashmir markhor but not tahr. Bamboo was also an important food, but the abundant leaves of rhododendron were seldom sampled. The tahr's principal food was dry grass. In late February animals spent hours foraging on *Danthonia schneideri, Cymbopogon thwaitesii, Arundinella nepalensis,* and other species. After obtaining a mouthful in one or more bites, an animal characteristically raised its head and chewed. I recorded the type of vegetation selected by two male tahr on two days in February. Of 155 mouthfuls, 75% consisted of grass, mainly wads of dead leaves and stems bitten off at the base, 7% of twigs and leaves from several shrubs and saplings, 6% of bamboo, 4% of dry forbs, and the rest of unidentified material which was at time obtained by first pawing the ground. By early March, green grass shoots became conspicuous, and tahr nibbled these. Yet dead grass continued to be eaten, even late in March when much green forage was available. Newly sprouted leaves of *Polygonum molle, Leucoceptrum canum* and other forbs and shrubs were at that time also a part of the diet. One tahr ate the blossoms of *Daphne gracilis,* and several others appeared to lick crustose lichens off rocks.

From mid-February to mid-March, when average daily minimum temperatures hovered around the freezing point, tahr tended to forage in the forest during the early morning hours. Not until sun reached the cliff, usually around 0830, did they venture into the open. But during the second half of March, when the average minimum temperature was 6°C, tahr were out at dawn, and, in fact, they may not have retreated into the forest at all during the night.

To reach the scattered patches of vegetation, tahr have to be good climbers, and, indeed, they traverse ledges and rock faces with an adeptness that can have few equals among ungulates. Their hooves are well designed for gripping rocks. 'The hoof pads are very soft, slightly convex posteriorly and surrounded by a hard horny rim which must serve a similar purpose to that of nails around the outside edge of mountaineers boots' (Anderson and Henderson 1961). Further traction is provided by the large dew claws. Tahr readily balance along ledges only a few centimetres wide and may leap with precision onto a small grass tussock growing on a sheer cliff 2 m below them. When confronted by a smooth, sloping rock face, an animal may rock back and forth and suddenly propel itself upward with a series of leaps, using the callus on each knee rather than the hooves to grip the rock fleetingly. The tahr's breast is calloused too according to Blanford (1888-91). Callus-like areas are also present on the hocks and these are used to supplement the hooves as brakes when an animal slides in a squatting position down a steep incline.

During rest periods, tahr reclined on exposed ledges, on rocky spurs, in thickets, almost any place which offered some level terrain ; animals also retreated beneath rock overhangs when such were available. On warm days, when shade temperatures reached 15 to 20°C, some tahr rested beneath trees yet others remained in the sun. Windy places were not avoided, and a male often rested on a promontory with his mane whipping in the breeze. ' It is common for a group of tahr to have one or two sentinels posted,' according to Anderson and Henderson (1961), but I saw no evidence of this. Tahr were never seen to paw the ground before lying down, behaviour which is, for example, conspicuous in markhor (Schaller and Mirza 1971). Animals either reclined with all legs tucked beneath the body or with one or both forelegs stretched forward. Cud-chewing was intermittent. Two subadult males were timed as they chewed a total of 25 boli. The average number of chews per bolus was 78 (65-87), and the time required to chew each bolus was 49 (40-65) seconds.

TABLE 3

AGE AND SEX OF TAHR INVOLVED IN LICKING INTERACTIONS

Animal licking	Animal being licked						
	Male				Female		Young
	III	II	I	Yearl.	Adult	Yearl.	
Male III							
Male II							
Male I					1		
Yearl. male			3		11		
Adult female	1		1	11	7	3	12
Yearl. female					3		
Young					8		

Tahr sometimes interrupted their rest or search for forage to groom themselves, licking their pelage and scratching it with hindleg or horntip. Social grooming, with one tahr licking the head and neck of another, was observed on 61 occasions. An interaction may be cursory, limited to a few licks, but it may also last for as long as 10 minutes. Licking was often reciprocal, with, for instance, a female first licking her young and then being groomed in return. On a number of occasions an animal invited licking by holding its head close to the muzzle of another. As Table 3 shows, most licking involved either two females or a female and a young; subadult and adult males seldom licked each other. Most interactions between adult females and yearling males, as recorded in Table 3, took place between the same pair of animals. Social grooming was a conspicuous activity among Himalayan tahr but not Nilgiri tahr, a difference for which I have no explanation.

REPRODUCTIVE BEHAVIOUR

The duration of the tahr's rut in the Himalayas is unknown, but since the gestation period is 6½ months (Caughley 1971), and young are born either in May and June (Stockley 1928; Prater 1965) or June and July (Blanford 1888-91; Lydekker 1924), most mating must take place between mid-October and mid-January. The age difference between some young in my study population was at least two months, and, in New Zealand, Caughley (1971) noted that births were spread over a period of almost three months. I saw a few instances of courtship behaviour and one copulation long after the termination of the main rut, and my notes are summarized here.

Males showed several behaviour patterns only in response to the presence of females:

Lip-curl: On 5 occasions a male either sniffed the anal area of a female or the spot where she had recently rested and then lifted his muzzle high with the upper lip curled. Yearling, class I, and class II males behaved in this fashion.

Low-stretch: A male may approach a female with his neck lowered and almost parallel to the ground and with his muzzle directed ahead or slightly raised. Males typically come up behind females in this way and sniff their anal area. This display, which is common to many ungulates, has in tahr become further elaborated. By raising the muzzle until it points almost straight up and retracting the neck, the shoulders of the male are transformed into a hump. Instead of remaining behind the female, the male now faces her rigidly, a position which exposes the front of the neck ruff to best advantage. His tail may be raised vertically and his teeth bared. Standing there, he may lift his muzzle higher and higher until it reaches above the level of his hump. This posture resembles the head-up display, with head raised and neck erect, of some ungulates (Walter 1961; Geist 1971).

Twist: While approaching a female in the low-stretch, a male may twist his head so that his horns point away from her. This gesture was seen twice.

Tooth-baring : As he faces a female in the low-stretch, a male sometimes retracts his lips to expose his incisor teeth and gums whose whitish colour contrasts markedly with the black lips and nose. It is possible that this gesture is an exaggerated form of lip-curling. If so, its function has been extended from one mainly designed to test the estrous state of the female by olfactory means to one of display value.

Head-shake : A male may interrupt the low-stretch in front of a female and jerk his head down, as if nodding vigorously, all the while shaking it rapidly from side to side. Then he resumes his former posture, often to shake again a few minutes later. One male displayed behind a female in this fashion.

Tongue-flick : As a male shakes his head, the tongue usually flicks rapidly in and out of his mouth. This gesture may also be displayed when a male follows an estrous female and when he faces her in a low-stretch.

Kick : During the head-shake, a male sometimes lifted a foreleg some 15 cm off the ground and kicked it limply and slightly bent at the carpal joint. Such kicks did not touch the female.

Males possibly add further emphasis to their displays by vocalizing, as noted in several goat species by Walther (1961), but I was too far away to hear sounds.

To place the display patterns into their natural context, the only lengthy courtship I witnessed is here described in a condensed form. The same animals were presumably involved, but I am not certain of this.

March 24. A group of 16 tahr is scattered over a cliff. At 1050 hours, a class II male approaches a female and gives the low-stretch in front of her. He stands with muzzle raised and head turned to one side for 5 minutes before he shifts his gaze to face her directly. She has her neck lowered and muzzle pointed downward. Soon he assumes a similar posture. (Both the averted glance and lowered head seem to be gestures of submission, showing lack of aggressive intent). After a few minutes the female suddenly jabs him lightly in the neck, but he merely lowers his head still more. Both stand motionless. When the male raises his head, she jabs him again, and he promptly assumes his former position. One hour after meeting the female, the male gives an intense low-stretch, muzzle straining skyward, then turns aside, licks himself, and ambles off. A class III male has been lying in full view 30 m away. He now displays the low-stretch to the female, grazes by her side a few minutes, then drifts off too.

March 25. At 0815, a female is attended by a class III male and two class II males, all somewhat separated from the main group. When a class II male approaches the female, the class III male by her side advances toward him in a hunch display (see below). The smaller male turns aside, joins the other class II male, and both rest at least 10 m from the courting pair. The class III male assumes the low-stretch, but the female ignores it and he reclines. At 0910 hours the approach of a class II male brings him to his feet, and a hunch display causes the interloper to veer off. Once again he faces the female in a low-stretch. For 15 minutes they stand, he with muzzle raised, she with head averted. After that both feed and rest. At 1105 hours, the female approaches the male who lifts his muzzle so high that the underside of his jaw faces her. She licks herself, advances, licks again. Whenever she moves, he adjusts his position so that his muzzle points at her. Suddenly he steps behind her, his shoulder by her rump. He gives a low-stretch coupled with a twist, then shakes his head and kicks. Twice more he shakes and kicks before moving around to face the motionless female. There he alternately low-stretches with teeth bared and shakes a total of 9 times. Occasionally he nudges the female with his nose as if to get her attention, for when she looks at him he intensifies his low-stretch. The female begins to feed at 1200 hours. Slowly the male steps behind her and rears on his hindlegs, mounting her. He thrusts 10 times, barely leaning against her, without eliciting a response. The two then feed and rest near each other without further courting for several hours.

March 26. I spot the tahr at 0800 hours. A class II male is giving the low-stretch with teeth bared to a female. Above the pair on a ledge is a yearling male and a young. The yearling butts the young so hard that it falls 2 m and collides with the courting male. Although he is nearly knocked off his feet, he calmly resumes his displaying. He alternately low-stretches and shakes, also giving occasional kicks and flicks of the tongue. Once he and the female touch horns. Between 0800 and 0835 hours he has 74 bouts of head-shaking. The female just stands, her head turned aside, but twice she jerks her horns at him aggressively and once butts his shoulder. At 0835 hours she walks off out of sight, followed at a distance by the male.

Of particular note is the gentleness with which courtship was conducted. The males did not press their attention on the female, but limited themselves to displaying and lingering nearby. Although I saw only one prolonged courtship, other observations suggest that it was a representative one. A class I male once followed a female closely for two hours, obviously interested in her yet never approaching closer than 1·5 m. Low-stretch displays, sometimes accompanied by tongue-flicking, teeth-baring, and, on one occasion, by kicking, were observed a total of 17 times on 10 different occasions, in addition to the instances related above. Fourteen of these displays were given by yearling males and the rest by subadult and adult ones. Females usually ignored such displays, but on two occasions, when importuned by a yearling, they rebuffed them. Once, when a yearling gave a low-stretch to a female, she jabbed him in the neck. He persisted and was rewarded with a poke in the rump. He in turn pressed his forehead against the base of her neck, a position which prevented her from horning him effectively. After a few futile jabs, she stepped aside and hooked his neck, and, as he turned to leave, his side too. Undaunted, the male displayed again, only to be butted in the shoulder. But all such attacks lacked vigour, they were limited to fairly gentle jabs. The males in turn did not retaliate, except twice to butt a female. On 9 occasions a pair also locked horns and tussled briefly and lightly. Alpine ibex (*Capra ibex*) and mountain sheep (*Ovis canadensis*) also court cautiously (see Geist 1971). Aside from other considerations, there would seem to be selective advantage in courting with restraint on cliffs.

Anderson and Henderson (1961) wrote that in New Zealand tahr ' the typical family group consists of a bull, a nanny, its kid, and either the offspring of the previous year or a 2-year-old, and together they move to a well-chosen piece of territory to remain for some 6 to 8 weeks.' Such ' monogamous grouping,' as these authors call it, was not evident in the one courtship I witnessed. Rather the largest male in the group claimed the estrous female, a pattern similar to that observed in markhor (Schaller and Mirza 1971) and ibex (Nievergelt 1967).

AGGRESSIVE BEHAVIOUR

Anderson and Henderson (1961) were impressed with the placid nature of tahr, noting that ' a more docile assembly would be hard to visualize.' While it is true that fighting is relatively uncommon, at least outside the rutting period, tahr do interact aggressively in a number of ways, using both direct and indirect forms of threat. Among the overt types were the following:

Jerk: A tahr may jerk down its head and point its horns at an opponent. The gesture signifies an intent to butt, and the threatened animal usually retreats a little. It was seen 15 times, directed mainly by females at courting males (6 times) and at young (4 times).

Lunge: On 3 occasions a female jerked down her head and at the same time lunged a metre or two at another animal, twice at a female, and once at a yearling male.

Jump: A young reared up on its hindlegs in front of another young on two occasions. A jump probably represents an intention movement to clash with a downward thrust of the horns.

Butt: Butting was the most common form of aggression in tahr. It consisted either of a push with the blunt edges of the horns or of a jab with the tips. The attack was directed at the neck of the opponent 8 times, the shoulders and sides 8 times, the thighs 3 times, and rump 5 times. Females delivered most butts, usually to courting males; and young butted each other several times seemingly in play. However, butting also occurs in serious fights as described by Roberts (1971):

> ' While observing the movements of a group composed of a mature bull, ten females and young, my attention was drawn to a large, lone bull about 500 feet above this herd when he started to smash into the turpentine scrub with hooves and horns and moved downhill towards the bull with the females....The two bulls confronted each other, whistled sharply, and began to wrestle like domestic cattle. The tactics appeared to be to try to put the opponent off balance, for after a period of pushing, twisting, and sliding downhill one bull was heaved off balance and the victor immediately shot his horns under him and ripped him in the belly. This upset him, and he tumbled down into the steep gully.'

Clash: On 18 occasions two tahr clashed horns, or, in the case of young, primarily foreheads. Sometimes one animal took the initiative, the opponent merely catching the blow with the horns, but at other times both jerked down their heads in unison. With locked horns they then twisted their heads and pushed each other back and forth. Two to four clashes sometimes followed in quick succession. None were violent and all were brief. Yearling males and females clashed most often, usually after the former had displayed the low-stretch. Once a young approached a yearling male playfully with its head low and waving from side to side until their horns met. A yearling male and a yearling female sparred gently 3 times, and two young clashed twice. Probably Himalayan tahr also rear up on their hindlegs in unison and lunge downward to clash their horns forcefully in the manner of Nilgiri tahr, ibex, markhor and other goats, but I did not see such behaviour.

Head-to-tail: Two young once stood parallel and head-to-tail as they hooked at each other's sides. On two other occasions a female and yearling male assumed similar positions, but circled rapidly with their heads cocked as if to jab. This method of fighting is similar to the one I termed shoulder-push in Nilgiri tahr except that the animals did not shove with their bodies.

As Table 4 shows, the various age classes differed in the amount of overt aggression. In 106 animal-hours[1] of observation, class I, II and III males asserted themselves only 5 times. Females were also unaggressive except when being courted. Young had a fairly high aggressive

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[1] One animal observed for one hour equals one animal-hour.

TABLE 4

TYPE AND FREQUENCY OF OVERT AGGRESSION USED BY VARIOUS AGE AND SEX CLASSES OF TAHR

Age and sex class	Jerk	Lunge	Jump	Butt	Clash[1]	Head-to-tail	Total no. Aggressions	No. aggressions per animal-hour of observation
Male III							0	0
Male II	2				(1)		3	·06 (·03)
Male I	1			1			2	·05
Yearl. male	1			1 (2)	6 (9)	(3)	22	·11 (·19)
Adult female	4 (6)	3		2 (12)	1 (10)	(3)	41	·04 (·14)
Yearl. female				1	3		4	·08
Young	1		2	5	6	2	16	·10

[1] In the clash and head-to-tail interactions both participants are included in the tabulation because both behaved aggressively.

Interactions during courtship are tabulated separately in parentheses. The data are based on 603 animal-hours of observation of tahr in groups.

rating, though some of their behaviour was playful, and yearling males had the highest. The goat-like blue sheep (*Pseudois nayaur*), which I observed during the same period as the tahr, showed a similar pattern of aggressive frequencies, except that young rated low (Schaller, in press). With respect to Nilgiri tahr, Schaller (1970) noted: 'A ranking of the classes based on relative frequency of fighting would place light brown males [class I] at the top, followed in decreasing order by yearlings, females, dark brown males and saddlebacks [classes II and III] and young.' The phase of a species' reproductive cycle has, of course, a considerable influence on aggressive frequencies. Schaller and Mirza (1971), for example, found that rutting adult male markhor were more aggressive than any other age and sex class.

Direct threats were mainly used by females toward individuals smaller than themselves, by one young toward another, and by courting pairs. Males, on the other hand, tended to employ various indirect forms of threat to intimidate each other as this example illustrates: After approaching to within 25 m, a subadult and yearling male halted and horned vegetation with vigorous sweeps of their heads, one using a grass tuft, the other bamboo. The subadult male then slowly came closer, once stopping to lick himself. Meanwhile the yearling grazed intensively. When the subadult had approached him to within 1·5 m, he licked and scratched himself, fed again, and groomed once more, a changing pattern he repeated 4 times. The subadult also groomed himself. But suddenly he hunched his back and stalked stiffly past the yearling. After that both foraged, drawing slowly parallel. They halted broadside to each other, standing motionless for 15 seconds with heads slightly lowered and averted before parting.

Horning vegetation: Nine instances of horning were observed, 5 of them by yearling males and the rest by subadult and adult ones. Some males horned during aggressive encounters, as the above example shows, but others thrashed vegetation in no particular context.

Hunch: On 5 occasions a subadult or adult male hunched his back, bunched his legs stiffly beneath him, lowered his neck either in an extended or retracted position, and pointed his muzzle obliquely downward. His tail was raised vertically, as in some low-stretch displays, exposing the small rump patch. The anus appeared puckered outward. With the hair on his nape and shoulders more erect than usual, he may walk or trot at another male in this posture, resembling a huge shaggy grass tussock with a black face peering from it. The threatened animal promptly avoided this apparition. At other times, the displaying animal walked broadside to his opponent, a position which did not cause immediate retreat.

Broadside : One tahr may stand close to another with its neck stretched somewhat forward, and with its muzzle held horizontally or tipped slightly up or down. Geist (1971) illustrates this posture in his book. The displaying animal either stands parallel to the other and facing in the same direction, a position which shows off the size of the ruff, or it halts in front or behind the other. A conspicuous feature of the display is that the muzzle is seldom pointed directly at the opponent but is averted to show a partial to complete profile. The threatened individual often responds by assuming the same posture with the result that the two display side by side or face to face, a metre or two apart, each with its muzzle turned away. I observed this display 7 times, once between 2 yearling males, 4 times between a subadult and a yearling male, once between an adult male and a yearling male, and once between an adult and yearling female. Most contacts were brief, lasting less than a minute, but on one occasion a subadult and a yearling male displayed to each other 3 times within a period of 50 minutes, each interaction lasting some 5 to 10 minutes. An animal sometimes terminated such an interaction by licking or scratching itself before turning away.

Tahr often groom themselves in conflict situations such as during courtship, when one male meets another, and when displaying broadside. For instance, during the brief meeting between the two males described earlier in this section, the subadult male groomed himself 7 times, but he did not lick or scratch during the 30 minutes preceding the interaction and only once in the hour succeeding it. A courting female groomed herself 19 times in 6 hours, usually when the male displayed to her. By indulging in an innocuous activity such as licking, tahr seemed to find relief from a tense situation or were able to terminate a confrontation without having to retreat abruptly.

DISCUSSION

In their physical characters, tahr appear to be evolutionary links between the rupicaprids or goat-antelopes, of which American mountain goat (*Oreamnos americanus*) and chamois (*Rupicapra rupicapra*) are well-studied representatives, and the true goats of the genus *Capra*. It would be of interest to find out if tahr are behavioural as well as morphological links, and this can best be done by comparing the courtship and aggressive displays of *Hemitragus* with those of various goats and rupicaprids. Schaller (1970) made a few such comparisons, and this account provides further information.

Treating first courtship among rupicaprids, Geist (1965) found that male mountain goats approach females from behind in a low-stretch, sometimes with tongue flicking. This may be followed by a vigorous kick that propels the female forward. ' If the female turns in horn-threat on him, the male turns his head away from her, and thereby shows the broadside of his face and beard' (Geist 1965). The low-stretch of mountain goats is less elaborate than that of tahr, but with the kick the reverse is true. Male mountain goats may sit on their haunches and paw 'rutting pits', as Geist (1965) called them, behaviour not seen in tahr. Among chamois, the male approaches a female in a low-stretch, and then 'the courting billy stands behind the nanny with his head erected, thereby displaying his white throat' (Krāmer 1969). Lip-curling is common among chamois, but kicking, twisting and other patterns found in tahr are not mentioned in Krāmer's detailed account. Rutting male chamois may shake their body vigorously and at the same time urinate with the result that fluid is sprayed over their pelage. The courtship displays of ibex, tur (*Capra caucasica*) and markhor are similar to those of Himalayan tahr in many respects (Table 5). However, some variations exist even in those displays which are found in all these species. When kicking, for example, Kashmir markhor tend to raise the leg fairly stiffly for a few centimetres, Alpine ibex may make pawing movements with their flexed foreleg (Walther 1961), and Himalayan tahr merely raise a leg limply, bent at the carpal joint. Head-shaking, so typical of courting Himalayan tahr, has not been reported in *Capra*, but ibex shake their head in a somewhat different manner as a form of threat (Walther 1961). A rutting *Capra* male typically urinates on his forelegs and face, and he may insert his penis into his mouth. Although tahr were not seen to do this, it is possible that such behaviour occurs during the rut. As Table 5 shows, some displays, such as the low-stretch, are found in all species listed, and, in fact, tend to be widespread among ungulates, whereas others are unique to one species. In general, the two rupicaprids appear to have fewer courtship patterns than members of the genus *Capra*, and Himalayan tahr share more displays with the latter than with the former. Nothing is known about courtship in other species of tahr.

It is necessary to note similarities and differences in the aggressive behaviour of Himalayan and Nilgiri tahr before fruitful comparisons with other genera can be made. Jerking, lunging, jumping, butting, frontal clashing, and horning are similar in the two species, but several differences also exist. At times two Nilgiri tahr 'stood parallel and facing the same direction and in unison jerked their head sideways rapidly once or twice thereby clashing their horn against one of the opponent's' (Schaller 1970). Such behaviour was not observed in Himalayan tahr. Both species horn while standing head-to-tail, but, in addition, Nilgiri tahr push with their shoulders and may kneel while fighting. The hunch differs somewhat in the two tahr : in the Nilgiri species the neck and head may be arched so far down that the muzzle points back between the legs, whereas in the Himalayan species the neck and head are merely stretched

TABLE 5

THE OCCURRENCE OF SOME MALE COURTSHIP PATTERNS IN SEVERAL SPECIES OF THE SUBFAMILY *Caprinae*

Pattern	Himalayan tahr (this study)	Mountain goat (Geist 1965)	Chamois (Krämer 1969)	Markhor (Schaller & Mirza 1971)	Alpine ibex (Walther 1961)	Tur (Steinhauf 1958)
Lip-curl	+	+	+	+	+	+
Low-stretch	+	+	+	+	+	+
Tooth-baring	+	—	—	—	—	—
Twist	+	—	—	+	+	?
Head-shake	+	—	—	—	—	—
Tongue-flick	+	+	—	+	+	+
Kick	+	+	—	+	+	+
Head-up	—	—	+	+	?	—
Urinating on body	?	—	+	+	+	+
Inserting penis in mouth	?	—	—	+	+	+
Digging rutting pit	—	+	—	—	—	—
Body-shake	—	—	+	—	—	—
Tail folded over rump	—	—	—	+	+	+

obliquely downward. Possibly the accentuated body posture of Nilgiri tahr is an evolutionary alternative to having a prominent display structure, such as the ruff of Himalayan tahr. I saw no display resembling the broadside of Himalayan tahr in Nilgiri tahr, but more work will no doubt clarify whether differences between the two species are qualitative or merely quantitative.

Mountain goats and chamois both jerk, lunge, jump, and butt. The former do not clash (Geist 1965) and the latter clash seldom (Krämer 1969), probably because their thin, pointed horns are unsuited to such activity. Animals with massive horns commonly clash, a fact true also for takin (*Budorcas taxicolor*), which usually are considered to be rupicaprids. All *Capra*, as well as blue sheep (*Pseudois*) and tahr clash not only by facing an opponent on all fours and bashing horns, but also by rearing upright in unison and with a downward lunge crashing horns together. Interestingly, Krämer (1969) reported this type of combat in chamois, indicating that such behaviour is not confined to the tribe Caprini as was previously assumed. The head-to-tail method of fighting was observed in young chamois by Krämer (1960). And Geist (1965) noted an analogous pattern in mountain goats: 'They fight keeping side by side while moving about one another. Goats strike up and sideways with their head, driving the horns into the opponent's ventral body region.' This display, common to both tahr species, has not been described for *Capra*, although domestic goats may stand side by side and push each other with the shoulders (Geist, pers. comm.). Neck-pushing, a form of combat in which one animal places its neck over the neck or shoulders of another and pushes downward, has been observed in young chamois (Krämer 1969) and in adult *Ammotragus lervia* (Haas 1959), a species intermediate between sheep and goats. Such behaviour has not been reported for *Hemitragus* and *Capra*.

Turning to indirect forms of threat, the mountain goat has a hunch posture which resembles the one described earlier for Nilgiri tahr. The hunch of the chamois is similar to that of the Himalayan tahr. Chamois present their broadside with humped back and either lowered or raised head, showing off their dorsal ridge of hair. Males may lip-curl in this posture, having apparently incorporated a sexual pattern into a threat one (Krämer 1969). The takin also exhibits the hunch display. The three Burmese animals in the Bronx zoo commonly arch their neck far down with chin tucked in and ears retracted, and moving stiffly, present their broadside. The head is often slightly averted and snorts may be given. The hunch in all these species is a broadside display, serving to intimidate an opponent by presenting a conspicuous profile. However, Himalayan tahr have an additional broadside display distinct from the hunch. It was my impression that this tahr sometimes used the hunch as a direct threat, rather than only as an indirect one as is the case in other species, whereas the broadside was solely an intimidation display. I observed hunch posture recently in wild goat *Capra hircus*. A broadside display has been described for markhor (Walther 1961).

There is almost no information about the Asian rupicaprids and many aspects of caprid behaviour remain unknown. Yet even this superficial review of some displays shows that the genus *Hemitragus* resembles both the caprids and rupicaprids in its behaviour. In the complexity of their courtship displays, Himalayan tahr seem to be closest to true goats, rather than to the mountain goat and chamois, but when individual patterns are considered the evidence remains somewhat equivocal. For example, tahr and rupicaprids probably do not fold their raised tail over the rump in the manner of true goats ; but, in contrast to the two rupicaprid species, Himalayan tahr and *Capra* use the twist. The hunch and head-to-tail are prominent aggressive patterns in both tahr species and in rupicaprids. Tahr resemble true goats in their other forms of aggression. Thus tahr show a behavioural affinity to both rupicaprids and *Capra*, a conclusion which supports the morphological evidence.

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Orchids of Nepal—7

BY

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(*With seven figures in two plates*)

[*Continued from Vol.* **69** (2) : 289]

This instalment describes the genera under Subtribe Sarcantheae of Kerosphaereae and Pleuranthae of Monopodiales. The genera being *Acampe*, *Aerides*, *Chiloschista*, *Doritis*, *Esmeralda*, *Gastrochilus*, *Luisia*, *Ornithochilus*, *Rhynchostylis*, *Sarcanthus*, *Vanda* and *Vandopsis*.

ARTIFICIAL KEY TO THE GENERA

A. Lip not spurred. Column without a foot, short and not winged—

B. Sepals & petals not spreading widely; lip not jointed at base, lower part of lip (hypochile) concave, apical part (epichile) broad and decurved........*Luisia*

BB. Sepals and petals spreading widely—

C. Lip not jointed at the base and shorter than the sepals ; fls. of medium size ....*Vandopsis*

CC. Lip jointed at the base and differentiated into a hypochile and epichile ....*Esmeralda*

AA. Lateral sepals adnate to the foot of the column, forming a mentum; spur when present distant from the base of the lip—

B'. Lip with a long claw, 3-lobed, not spurred; column winged. Lateral sepals adnate with the foot of the column to form a conical mentum......*Doritis*

B'B'. Lip saccate at its union with the foot of the column; column wingless; basal part of lip (hypochile) forming a hairy sac; lateral lobes of lip absent ....*Rhynchostylis*

B'B'B'. Lip adnate to the base of the column, gibbous or shortly spurred; sidelobes of lip large and erect; leafless when flowering, stem absent......*Chiloschista*

B'B'B'B'. Lip jointed to the foot of the column, spurred.....................*Aerides*

AAA. Lip saccate or spurred at the base; column wingless—

D. Sepals and petals fleshy and widely spreading—

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E. Flowers large ; labellum large, sidelobes large, base saccate or spurred ....*Vanda*

EE. Flowers small ; labellum adnate to the base of the column, spurred ..*Sarcanthus*

EEE. Flowers small ; base of labellum with a long or short and wide spur, sidelobes absent or very small...............................*Gastrochilus*

DD. Sepals and petals not spreading—

F. Flowers small and fleshy, sepals and petals concave..........*Acampe*

FF. Flowers large, sepals spreading, lateral sepals connate at the base of the lip and together forming the mentum...................*Ornithochilus*

Acampe Lindl.

The name probably refers to the small and brittle flowers. Plants are epiphytic and the leaves are fleshy and slightly recurved. The floral structures are very much like those of *Sarcanthus*, and in fact the genus is treated as a section of *Saccolabium* by Hooker. According to Lindley this genus is characterised by the small, brittle and inflexible flowers.

ARTIFICIAL KEY TO THE SPECIES OF *Acampe*

Leaves more than 15 cm long ; flowers pale yellow ....*longifolia*

Leaves *c*. 10 cm long, obliquely notched ; flowers dark yellow..........*papillosa*

Acampe longifolia (Lindl.) Lindl. Fol. Orch. 1 : 1853 ; Holttum, 621, 1953. *Vanda longifolia* Lindl. in Lindl. & Paxt. Flow. Gard. 2 : 21, 1851–52. *Saccolabium longifolium* Hk. f. in Fl. Brit. Ind. 6 : 662, 1890 ; King & Pantl. 220, t. 292, 1898.

Stem robust and densely leafy ; leaves more than 15 cm long, upper part broader than the lower. Flowers fleshy *c*. 1·5 cm in diam., delicately fragrant ; sepals and petals pale yellow with deep brown stripes, dorsal sepal 1·3 cm long, obtuse, lateral sepals slightly keeled, petals slightly smaller than the sepals. Lip 1 cm long, fleshy, white with a few purple spots, base saccate, sidelobes erect, midlobe reflexed and hairy at the base. Flowering during September and October. Distributed at 305 to 1075 m. Common.

A. papillosa (Lindl.) Lindl. Fol. Orch. 2, 1853. *Saccolabium papillosum* Lindl. Bot. Reg. t. 1552, et Gen. et Spec. Orch. 222, 1830 ; F.B.I. 6 : 63, 1890.

Leaves about 10 cm long, obliquely notched. Scape 2·5–5 cm long ; flowers 1·5 cm in diam. : sepals and petals dark yellow spotted with dull brown. Midlobe of lip ovate, rosy, spur conical, pubescent within. Flowering during September to November. Distributed at about 610 m. Collected from Kuroanadi at Hittaura, Bindraban forest, Hittaura, Narayani.

Aerides Lour.

In vegetative appearance these orchids resemble the Vandas. The inflorescence is an elongated pendulous raceme bearing a number of flowers.

ARTIFICIAL KEY TO THE SPECIES OF *Aerides*

Terminal lobe of lip large, hastate-rounded ; spur short and straight . . *multiflorum*

Terminal lobe of lip small, oblong-lanceolate, incurved ; spur long and incurved . . . . *odoratum*

Terminal lobe of lip slightly dilated and bifid ; spur long and straight. . . . *longicornu*

Aerides longicornu Hk. f. Icon. Pl. 22, t. 2127, 1889 et F.B.I. 6 : 44, 1890.

Flowers white, sepals and petals with crisp margin, lateral sepals much larger than the petals, petals orbicular or oblong. Lateral lobes of lip curved forwards, shorter than the long spur, mid-lobe narrow, clawed, tip slightly dilated, bifid. Flowering during September and October. Collected from Sundarijal area at *c.* 1525 m.

A. multiflorum Roxb. Pl. Corm. 3 : 63, t. 271, 1820 ; F.B.I. 6 : 44, 1890 ; King & Pantl. 212, t. 283, 1898 ; Duthie, 142, 1906 ; Holttum, 694, 1955 ; Hara, 425, 1966. (Fig. 1).

Inflorescence very densely flowered, longer than the leaves ; flowers white or rose-purple, spotted with darker purple spots, *c.* 2 cm in diam., fragrant. Sepals and petals subequal, tips rounded. Lip twice as long as the sepals, purple but darker in the middle, lateral lobes small and recurved, midlobe hastate, *c.* 1·7 cm long, tip rounded, spur short and straight. Flowering during June and July. Distributed at 304 to 915 m. Collected from Dhupu to Wana, Hittaura, locality unknown (Herklotts).

A. odoratum (Poir.) Lour. Fl. Cochinch. 525, 1790 ; F.B.I. 6 : 47, 1890. *Epidendrum odoratum* Poir. Encycl. Supp. 1 : 385, 1811.

Inflorescence many-flowered equalling or longer than the leaves. Flowers purple or whitish purple, sweet smelling, 2·5 to 3·8 cm in diam., sepals and petals 1·2 cm long, lateral sepals much longer than the dorsal sepal and petals. Lip funnel-shaped, prolonged at the base to form a spur, lateral lobes erect, white midlobe linear, marginate, greenish at its apex and spotted all over, tip 3-lobed. Flowering during July and August. Distributed at 304 to 915 m. Collected from Hittaura area.

Chiloschista Lindl.

Dwarf, epiphytic orchids, leafless when flowering. The name alludes to the cleft lip. Hooker (Fl. Brit. Ind.), and King & Pantl. placed it as a section under *Sarcochilus*. Pfitzer and J. J. Smith recognised the genus as an independent one. Later Schlecter (1927) again united it with *Sarcochilus*.

ARTIFICIAL KEY TO THE SPECIES OF *Chiloschista*

Flowers white	....*usneoides*
Flowers yellow, spotted with purple	..................*lunifera*

Chiloschista lunifera (Reichb. f.) J. J. Sm. Fl. Buitenz. 6 : 553, 1905. *Thrixspermum luniferum* Reichb. f. in Gard. Chron. 1886, 786, 1886. *Sarcochilus luniferus* (Reichb. f.) Bth. ex Hk. f. in Bot. Mag. 115, t. 7044, 1889 et Fl. Brit. Ind. 6 : 37, 1890 ; King & Pantl. 207, t. 276, 1898.

Roots tufted and stem much reduced. Inflorescence elongate 7-15 cm long, many-flowered ; flowers *c.* 1·5 cm in diam., yellow spotted with purple. Sepals spreading, oblong, obtuse. Lip 3-lobed, sidelobes linear-oblong, obtuse, midlobe truncate, emarginate. Flowering during February and March. Distributed at 1300 to 1980 m. Collected from Bhadgaon to Dhulikhel, Hittaura.

Hooker remarks ‘ except in the colour of the flower, no difference from *usneoides* ’.

C. usneoides (Don) Lindl. Gen. et Spec. Orch. 219, 1830 et Bot. Reg. sub. t. 1522, 1832. *Epidendrum usneoides* D. Don, Prodr. Fl. Nep. 37, 1825. *Sarcochilus usneoides* Reichb. f. in Walp. Ann. 6 : 497, 1861 ; F.B.I. 6 : 37, 1890.

Roots tufted and stem absent. Inflorescence 7 to 15 cm long, densely flowered. Flowers *c.* 1·3 cm in diam., white, sepals spreading, oblong, obtuse. Sidelobes of lip erect, linear-oblong, obtuse, disk between the lobes pubescent, midlobe truncate and emarginate. Flowering during February and March. Distributed at 1525 to 1830 m. Collected from Sundarijal, Sheopuri area, locality unknown (Herklotts).

Doritis Lindl.

According to Schultes and Pease the name refers to the hastate lip or perhaps to *Doritis*, one of the names of the goddess Aphrodite, The column is winged, and its foot forms a spur-like mentum with the sidelobes of the lip. The plants have short stem and the few leaves are clustered.

Doritis taenialis (Lindl.) Benth. in Benth. & Hook. f. Gen. Pl. 3 : 574, 1883 ; F.B.I. 6 : 31, 1890 ; King & Pantl. 199, t. 266, 1898 ; Duthie, 138, 1906 ; Hara, 433, 1966. *Aerides taenialis* Lindl. Gen. et Spec. Orch. 239, 1833.

Inflorescence few-flowered (about 6), pendulous ; flowers mauve-purple, *c*. 2 cm in diam., dorsal sepal oblong, lateral sepals broader, petals shorter than the sepals. Lip adnate to the foot of the column, sidelobes of lip very narrow, spathulate, reflexed on the disk, midlobe dark red. Flowering during May and June. Distributed at 915 to 1830 m. Collected from Chainpur to Mialay, Naudhara, Nagarjung.

Esmeralda Reichb. f.

Schultes and Pease giving the etymology of the name mention that it may possibly refer to the overwhelming beauty of the flower which makes this orchid a jewel in collections or perhaps to the very deep green hue of the foliage. Hawkes considered *Esmeralda* a synonym of *Arachnanthe*.

Esmeralda clarkei Reichb. f. Gard. Chron. 2 : 552, 1886.

Arachnanthe clarkei Rolfe, Gard. Chron. 2 : 567, 1888 ; F.B.I. 6 : 28, 1890. *Arachnis clarkei* (Reichb. f.) J. J. Sm. in Nat. Tijdschr. Ned. Ind. 72 : 76, 1912. (Fig. 2.)

Inflorescence *c*. 20 cm long, few-flowered (3-4), flowers *c*. 7·5 cm in diam., fleshy, very fragrant ; sepals and petals falcate, bright chestnut brown with yellowish stripes, dorsal sepal erect. Lip almost the length of the petals, base narrowed, sidelobes short, broad, erect, midlobe ovate-cordate, obtuse, a small lobule at apex, surface with a number of ridges. Flowering during February and March and again in November. Collected from Sundarijal at 1830 m, locality unknown (Herklotts).

Gastrochilus D. Don

As the lip is belly-shaped, the name refers to that character. J. J. Smith who had previously treated *Gastrochilus* as a section of *Saccolabium*, raised it to generic level. *Gastrochilus* can be differentiated from *Sarcochilus* R. Br. and *Saccolabium* Bl. by the fleshy flowers. Lip, immovable midlobe, flat, hairy, and fringed column very short, footless. The pollinia are shorter than the caudicles.

ARTIFICIAL KEY TO THE SPECIES OF *Gastrochilus*

Spur short—

Sidelobes of lip present, midlobe fringed, papillose-hairy........*calceolaris*

Sidelobes of lip absent, midlobe entire, surface more or less glabrous (not hairy) ....*distichus*

Spur long with a bilobed apex ....*affine*

Gastrochilus affine (King & Pantl.) Schltr. Fedd Rep. 12: 314, 1913; Hara, 434, 1966. *Saccolabium affine* King & Pantl. Ann. Roy. Bot. Gard. Calcut. 8 : 228, t. 304, 1898.

Flowers smaller than those of *G. distichus,* lip not sub-orbicular but transversely elongated, tip of midlobe obtuse, lateral margins with irregular dentation, two lamellae in the centre of the midlobe; spur conical with a slightly bilobed apex. Authority Hara.

G. calceolaris D. Don, Prodr. Fl. Nep. 32, 1825; Holttum, 675, 1953; Hara, 453, 1966. *Aerides calceolare* Ham. ex Smith, Rees. Cyclop. 39 (11), 1818; *Saccolabium calceolare* Lindl. Gen. et Spec. Orch. 223, 1833; F.B.I. 6: 60, 1890; King & Pantl. 225, t. 300, 1898. (Fig. 3).

Scape spotted purple, stout and fleshy, shorter than the leaves, flowers yellow or greenish, speckled with red-brown, waxy, *c.* 1·5 cm in diam., mildly fragrant; sepals and petals 6 mm long. Lip yellow and speckled with brown spots, sidelobes 1 mm, white, midlobe 3 mm long, twice as wide at the base, margin white, fringed, central part yellow, hairy all over, spur short also yellow. Flowering during February and March. Distributed at 1525 to 1830 m. Collected from Rhingmo to Jubing, Sheopuri, Godavari.

G. distichus (Lindl.) O. Ktz. Rev. Gen. Pl. 2: 661, 1891; Hara, 435, 1966. *Saccolabium distichum* Lindl. in Journ. Linn. Soc. 3: 36, 1859; F.B.I. 6: 64, 1890; King & Pantl. 227, t. 303, 1898; Duthie, 148, 1906.

Inflorescence equalling the leaves, flowers greenish and spotted with brown. Sepals and petals obovate-oblong, green spotted with brown. Lip with a saccate spur, sidelobes absent, midlobe small, semicircular, fleshy with two calli at the base. Flowering during January and February. Collected from Borlong forest at *c.* 2285 m.

Luisia Gaud.

This orchid is named after a Spanish botanist Don Luis de Torres.

ARTIFICIAL KEY TO THE SPECIES OF *Luisia*

Flowers 10 mm long	*trichorrhiza*
Flowers 6 mm long	*teretifolia*
Flowers 4 mm long	*micrantha*

Luisia micrantha Hook. f. in Fl. Brit. Ind. 6 : 23, 1890.

Flowers small, *c.* 8 mm in diam., and 4 mm long, greenish lateral sepals ovate, subacute, midrib very stout, dorsal sepal similar to the petals, petals oblong, obtuse, 1-nerved. Lip as long as the sepals, hypochile oblong, concave, two strong teeth, epichile fleshy, small. Flowering during August and September. Collected from Hittaura at *c.* 510 m.

L. teretifolia Gaud. Bot. Freyc. Voy. 427, t. 37, 1826 ; F.B.I. 6 : 22, 1890 ; King & Pantl. 202, t. 271, 1898 ; Duthie, 140, 1906 ; Hara, 443, 1966.

Inflorescence few-flowered (2-3), flowers small, *c.* 1·8 cm in diam., and 6 mm long, foul smelling. Lateral sepals subacute, petals linear-oblong, obtuse, hardly longer than the sepals, yellowish-green. Lip equalling the sepals, usually dull purple and with 5 vertical lines. Flowering during March and April. Collected from Dhunibesi, Nagarjung at *c.* 1650 m.

L. trichorrhiza Bl. Rumphia 4 : 50, 1848 ; F.B.I. 6 : 23, 1890 ; Duthie, 140, 1906.

Inflorescence 4-5-flowered, flowers *c.* 2·5 cm in diam., and 1 cm long. Sepals unequal with faint purple lines, petals as long as the lateral sepals. Lip obovate-oblong, rather longer than the sepals, flat, dull purple, constricted at the base of the cordate epichile, marking the hypochile. Flowering during March and April. Distributed at *c.* 750 m. Collected from Dhulikhel to Kuwapani, Pokhra.

Ornithochilus Wall. ex Lindl.

The name is descriptive of the bilobed lip with the tips divaricate and verticle resembling a bird in flight.

Ornithochilus difformis (Wall. ex Lindl.) Schltr. Orch. Sino-Jap. 227, 1919 : Hara, 446, 1966. *Aerides difforme* Wall. ex Lindl. Gen. et Spec. Orch. 242, 1833 ; *Ornithochilus fusca* Wall. ex Lindl. Gen. et Spec. Orch. 242, 1833 (pro. syn.) ; F.B.I. 6 : 76, 1890 ; King & Pantl. 200, t. 268, 1898 ; Duthie, 139, 1906.

Inflorescence somewhat pendulous, twice or thrice longer than the leaves, many-flowered, flowers *c.* 1·25 cm in diam. Sepals and petals greenish-yellow with reddish stripes. Lip much larger than the sepals, clawed, yellow, sidelobes quadrate, striped with brown, midlobe clawed and two lobulate, reddish or purple lower down, spur long, yellow. Flowering time June. Collected from Nagarjung at 1650 m.

Rhynchostylis Bl.

Usually stout and short-stemmed epiphytic orchid. Allied to *Saccolabium* Bl. and *Aerides* Lour. but can be distinguished by the scarcely lobed lip and the not sharply distinguished from the column-foot; the laterally compressed spur is directed backwards, and the rostellum is beaked. These orchids are popularly known as ' Fox-tail Orchids '.

Rhynchostylis retusa (Linn.) Bl. Bijdr. 286, 1825 ; F.B.I. 6 : 32, 1890 ; King & Pantl. 213, t. 284, 1898 ; Duthie, 143, 1906 ; Holttum, 697, 1953 ; Hara 449, 1966. *Epidendrum retusum* Linn. Sp. Pl. 953, 1753. *Saccolabium guttatum* Lindl. (in Wall. Cat. 7308) Gen. et Spec. Orch. 220, 1833. (Fig. 4.)

Stem robust and completely hidden by the imbricating leaf-bases ; leaves arching gracefully, very close together, leathery, apex obliquely bilobed. Inflorescence *c.* 25-30 cm long, densely flowered. Flowers white, spotted with pink or purple, *c.* 1·8 cm in diam., fragrant, waxy; lateral sepals *c.* 1 cm long, gibbously orbicular-ovate, obtuse or apex drawn out, dorsal sepal *c.* 1·2 cm long, oblong; petals 1·2 cm long, elliptic, obtuse. Epichile of lip usually cuneiform, emarginate, saccate, purple. Flowering during May and June. Distributed from 304 to 1830 m but commonly at about 915 m. Collected from Naikot, Dhupu to Wana, locality unknown (Herklotts).

Sarcanthus Lindl.

The name refers to the very fleshy flowers of most of the species. According to Holttum (1953) ' this is the largest genus of the small-flowered orchids of this group. The flowers are always rather fleshy and last several days. Their most distinctive feature is the large callus at the back of the spur. The back callus also sometimes interlocks with the front callus....' The flowers are complex in structure and difficult to describe.

ARTIFICIAL KEY TO THE SPECIES OF *Sarcanthus*

Leaves filiform ; raceme 15 – 20 cm long, curved....................	*filiformis*
Leaves flat; racemes branched (panicle), 30 – 35 cm long	*racemifer*

Sarcanthus filiformis Lindl. Bot. Reg. misc. 61, 1838 ; F.B.I. 6 : 66, 1890.

Epiphytic with leaves filiform and narrowly cylindrical. Inflorescence rather dense, many-flowered, curved 15-25 cm long; flowers *c.* 8 mm in diam.; sepals oblong, obtuse, petals smaller and narrower, both dark purple with margin and midrib green. Lip broadly conical, fleshy, white with a broad yellow base, sidelobe acute, incurved, midlobe short, white, callus very large. Flowering time during August and September. Collected at 910 m at Hittaura and Narayani.

S. racemifer (Wall.) Reichb. f. in Walp. Ann. 6: 891, 1861. *Aerides racemiferum* Wall. ex Hook. f. in Fl. Brit. Ind. 16: 68, 1890. *Sarcanthus pallidus* Lindl. Bot. Reg. 78, 1840; F.B.I. 6 : 69, 1890.

Epiphytic with leaves flat and broad, obtusely bilobed, very thick. Inflorescence erect, branched, loosely-flowered, flowers *c.* 8 mm in diam. Sepals and small petals oblong, obtuse, dark purple with edges yellow. Lip white, sidelobes triangular, acuminate, midlobe small and incurved, reniform, fleshy beak, spur cylindrical, obtuse, saccate, thick-walled, as long as the sepals but shorter than the ovary, callus bilobed. Flowering during June and July. Distributed at 1220 to 1525 m. Collected from Dhankutta, Pokhra.

Vanda Jones

The name refers to the Sanskrit word 'banda' which means an epiphyte but also used for parasitic plants. The *Vanda* orchids can be distinguished by the fleshy 3-lobed lip. The inflorescence is normally simple and erect; it usually arises from the leaf-axils or from opposite the leaf-bases and near the upper part of the plant but not at its apex.

ARTIFICIAL KEY TO THE SPECIES OF *Vanda*

A. Lip spurred at the base—
  B. Sepals & petals spreading—
    C. Flowers small, disk of lip without ridges ....*parviflora*
    CC. Flowers *c.* 3·5 – 5 cm in diam. disk of lip with fleshy ridges, sidelobes small and rounded...*tessellata*
    CCC. Flowers *c.* 7·5 – 10 cm in diam., disk of lip with sidelobes broad and incurved ....*teres*
  BB. Sepals and petals incurved—
    D. Sidelobes erect and triangulars; flowers 5 cm in diam..............*cristata*
    DD. Sidelobes rounded; flowers 2·5 cm in diam.......................*pumila*
AA. Lip gibbous, not spurred or saccate. Flowers *c.* 2·5 cm in diam.......*alpina*

Vanda alpina Lindl. Fol. Orch. 10, 1853; F.B.I. 6 : 53, 1890; King & Pantl. 217, t. 289, 1898; Duthie, 146, 1906; Hara, 452, 1966. *Luisia alpina* Lindl. Bot. Reg. 1858, misc. 56, 1858.

Racemes with usually 2 flowers; flowers nodding, faintly fragrant, *c.* 2·5 cm in diam., sepals and petals narrow, yellowish-green. Lip fleshy, sidelobes rounded, purplish inside, midlobe concave, ovate, retuse, pale yellow with purple shallow ridges, spur absent but gibbous. Flowering during May, one specimen collected from Sheopuri area at *c.* 1370 m.

V. cristata (Wall.) Lindl. Gen. et Spec. Orch. 216, 1833; F.B.I. 6 : 53, 1890; King & Pantl. 216, t. 287, 1898; Duthie, 146, 1906. *Aerides cristatum* Wall. ex Hook. f. in Fl. Brit. Ind. 6 : 53, 1890. (Fig 5.)

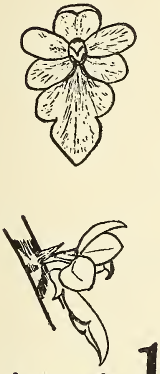
Inflorescence erect, 3-5-flowered, flowers *c.* 5 cm in diam., waxy, fragrant. Sepals and petals narrow, incurved yellowish-green. Lip green on the underside, upper surface marked with purple stripes and spots, sidelobes of lip erect, triangular, truncate; midlobe oblong, golden yellow and striped with purple, tip with two divaricate oblong lobes and a fleshy beak pointed downwards, spur short and conical. Flowering time during March and April, even on to June. Collected from West Nepal (Parker), locality unknown (Herklotts). (The description and the flowering time have been based on the study of plants growing in Botanic Garden, Godavari).

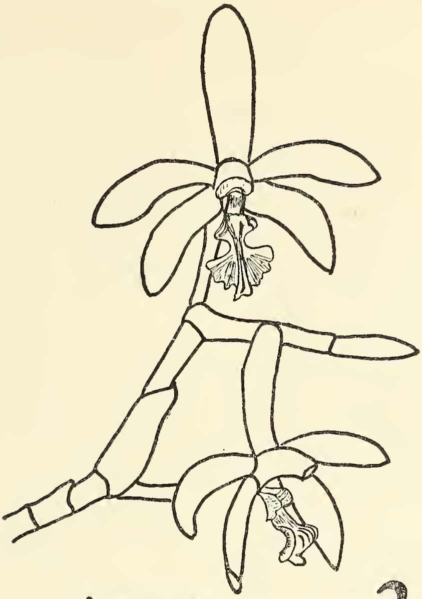
V. parviflora Lindl. in Bot. Reg. 30, Misc. 45, 1844; F.B.I. 6; 50, 1890: King & Pantl. 215, t. 286, 1898; Duthie, 145, 1906. *Aerides testaceum* Lindl. Gen. et Spec. Orch. 238, 1833; *Vanda testacea* (Lindl.) Reichb. f. in Gard. Chron. 2: 166, 1877.

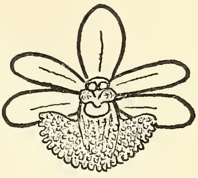
Inflorescence arising below the leaves, rather loosely 5-7-flowered, flowers *c.* 1·5-2 cm in diam. Sepals and petals usually flesh-coloured, subequal, obovate-spathulate, obtuse, spreading. Lip 3-lobed, sidelobes small, incurved midlobe large, broadly oblong, fleshy, crenate at the apex, white, surface blue and purple-spotted, spur long and curved. Flowering during May and June. Distributed at 305-915 m. Collected from Simalbasa, Hittaura.

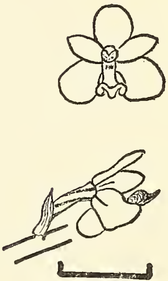
V. pumila Hk. f. in Fl. Brit. Ind. 6 : 53, 1890, et in Ann. Roy. Bot. Gard. Calc. 5 : 45, 1895.

Inflorescence about 15 cm long, loosely 2-4-flowered, flowers *c.* 2·5 cm in diam., fragrant; sepals and petals narrow, pale yellow or greenish-white. Lip 3-lobed, sidelobes erect and rounded, midlobe broadly ovate, concave, obtuse, pale and streaked purple, spur conical and as long as the midlobe. Flowering during April and May. Distributed at 1220 to 1525 m. Collected from Dhunibesi, Hokse.









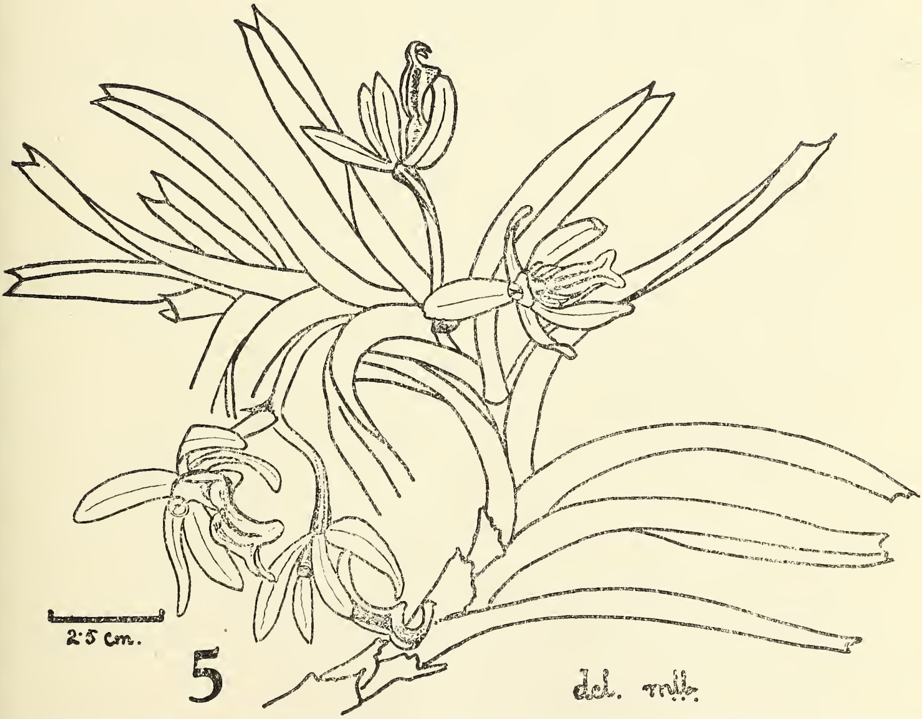
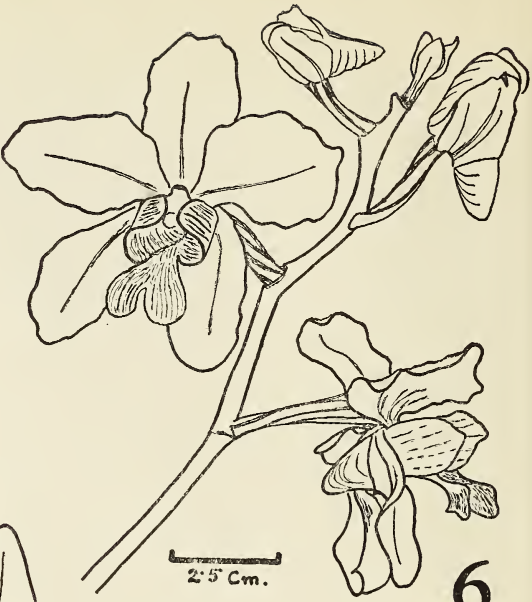

2·5 Cm.
5
del. mlb.

Fig. 1. *Aerides multiflorum* Roxb. Fig. 2. *Esmeralda clarkei* Reichb. f. Fig. 3. *Gastrochilus calceolaris* D. Don. Fig. 4. *Rhynchostylis retusa* (Linn.) Bl. Fig. 5. *Vanda cristata* (Wall.) Lindl.



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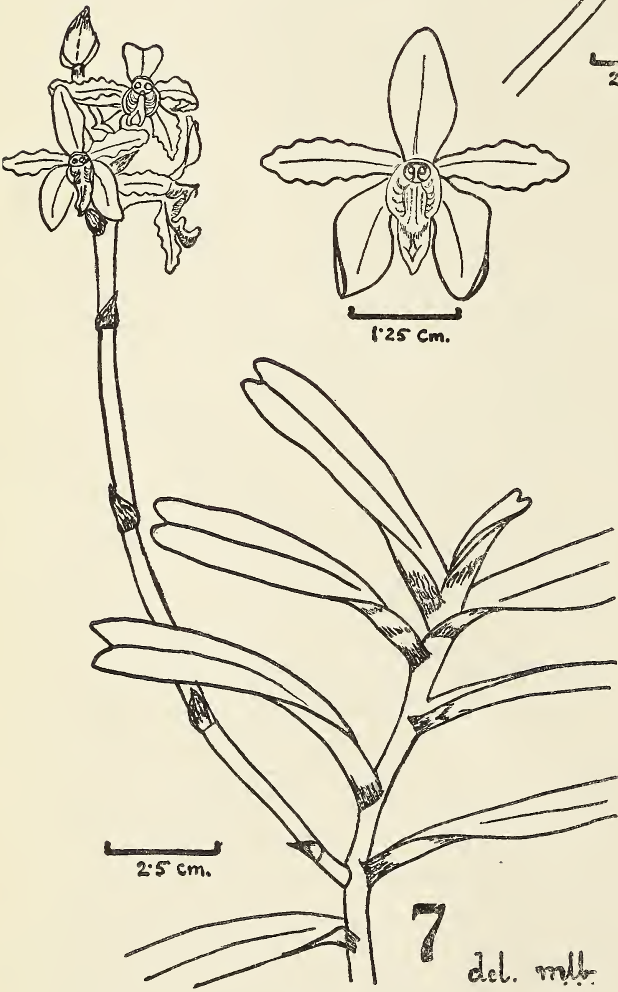
1·25 Cm.
2·5 cm.
del. mlb.

7

Fig. 6. *Vanda teres* (Roxb.) Lindl. Fig. 7. *Vandopsis undulata* (Lindl.) J.J. Sm.

V. tessellata (Roxb.) Hook. ex G. Don, Loud. Hort. Brit. 372, 1830. *Epidendrum tessellatum* Roxb. Pl. Corom. 1 : 34, t. 42, 1795. *Vanda roxburghii* R. Br. in Bot. Reg. 6, t. 506, 1820; F.B.I. 6: 52, 1890; Duthie, 116, 1906. *V. tesselloides* Reichb. in Walp. Ann. 6: 864, 1861.

Inflorescence 5-10-flowered, longer than the leaves. Flowers *c.* 5 cm in diam., tesselated with brown, sepals *c.* 2·5 cm long, petals 2·3 cm long, clawed, obovate, waxy, tessallations yellowish-green or slightly bluish, margins white. Lip nearly as long as the sepals, side-lobes small, purple-spotted, midlobe panduriform, dull violet and paler at the base, tip dilated, truncate, 2-lobed, disk with fleshy ridges, spur conical. Flowering during July and August. Distributed in the sub-Himalayan region. Collected from Bhairwa, Hittaura, Narayanghat.

V. teres (Roxb.) Lindl. Gen. et Spec. Orch. 217, 1830; F.B.I. 6: 49, 1890. *Dendrobium teres* Roxb. Fl. Ind. 3 : 485, 1832. (Fig. 6).

Inflorescence 15-30 cm long and with 3-6 flowers. Flowers *c.* 7·5-10 cm in diam., white or mauve, fragrant. Sepals and petals undulate, lip hairy towards the base, side lobes broad, incurved, deep yellow or lighter and spotted crimson, midlobe much larger, deeply cleft, purple, spur conical. Flowering during May and June. Distributed at 305 to 610 m. Collected from Hittaura, locality unknown (Herklotts).

Vandopsis Pfitz.

These are robust and spectacular orchids. The name implies that these orchids resemble *Vanda.* According to Hawkes they are allied to *Renanthera* Lour. and *Arachnis* Bl.

Vandopsis undulata (Lindl.) J. J. Sm. in Nat. Tijdschr. Ned. Ind. 72 : 77, 1912. *Vanda undulata* Lindl. Journ. Linn. Soc. 3 : 42, 1859. *Stauropsis undulata* (Lindl.) Benth. ex Hk. f. Fl. Brit. Ind. 6 : 27, 1890; King & Pantl. 205, t. 257, 1898. (Fig. 7).

Inflorescence long, rachis thickened, 8-12-flowered, flowers *c.* 3·25 cm in diam., white, flushed with pink, waxy, fragrant; sepals oblanceolate, acuminate, margins undulate, lateral sepals deflexed, petals similar but smaller. Lip greenish-yellow or light yellow, base saccate, adnate to the sides of the column, sides pink, midlobe laterally compressed, 3-ridged, tip truncate, purplish. Flowering during March and April. Distributed at about 2135 m. Collected from Kaituka, Chandragiri, Godavari, locality unknown (Herklotts).

(*to be continued*)

Bionomics and Distribution of the land leeches of Kumaon Hills, U.P.

BY

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(*with* 5 *text-figures*)

INTRODUCTION

Land leeches are reported from almost all the hill areas in India where they swarm in an incredible profusion, and prove a very harmful pest to animals and mankind by sucking their blood. Very little accurate information concerning their activities is recorded. It is a well-known fact that they are very active during rainy weather but no one appears to know what actually becomes of them during the dry season, and their appearance immediately with the coming of rains, raises the question, 'Whence do they appear ?'. Some believe that they lay eggs and die with the advent of dry season, and that those which reappear on its conclusion are a new generation. There is little literature on the subject.

Extensive field and laboratory observations were made for three continuous years, and it has been possible to gather first-hand information about several hitherto unknown and doubtful aspects of land leeches, which are recorded here.

Although several species of land leeches, commonly found in Kumaon Hills, were collected, the observations recorded here are based primarily on the behaviour of two very common species, *Haemadipsa zeylanica agilis*, and *Haemadipsa montana*, which should hold good for other varieties of land leeches elsewhere in India.

The Junior author owns an agricultural farm and also an apple orchard, in Kumaon and thus had the advantage of first hand knowledge, extending over several years, of the activities of land leeches throughout a calendar year. His valuable field observations of these creatures form subject matter of this paper.

HABIT

At the advent of rains, leeches emerge from hibernation and begin to swarm to the upper limits of the hills. During rains they are found on almost all patches of land in oak forests and are especially abundant along the foot-paths frequented by cattle, wild animals, and man. They are also present in large numbers in grass pastures adjacent to oak forests, which are frequently visited by man and domestic animals.

Moore (1927) reports that *Haemadipsa sylvestria* from Assam, enters water voluntarily during dry season and swims actively. Contrary to this, the common leeches of Kumaon region *Haemadipsa zeylanica agilis*, and *Haemadipsa montana*, do not enter streams during short dry spells during the monsoon and even in the prolonged drought period of hibernation. Their avoidance of wet and flooded areas of the forests suggests that they dislike such habitats.

In the early part of monsoon, after the first few showers, leeches are very active but when incessant rains set in, they crawl under dead oak leaves on the ground. During bright sun-shine also they hide under leaves and stones and resume their activities when it is cloudy and humid. They remain active during night, but become much more alert when rays of the early morning sun fall on them. Leeches are seen either standing erect on their posterior suckers, swaying all around, or moving on the ground. When erect they appear like small twigs among the layers of dry oak leaves. Leeches living in forests and swamps, may climb on leaves and branches, and wait until a suitable mammalian prey present itself.

After a full blood-meal, they crawl beneath the leaves or under some suitable cover and remain in a sluggish condition for a number of days, but those that do not get an opportunity of procuring a meal come out at the slightest disturbance.

Wounds caused by their bites generally heal up within a few days, though land leeches have the peculiar habit of biting repeatedly at the same spot which sometime causes pathological complications. Sometimes the bite becomes an open sore, probably due to secondary infection. Landleeches attack all the warm-blooded animals but find difficulty in getting blood from animals with thick fur covering. Some bare portion of the body of animals is selected for this purpose.

HABITAT

Haemadipsa zeylanica agilis and *Haemadipsa montana*, along with other land leeches are found abundantly between heights 5000 and 6000 ft. and range from ravines as low as 3000 ft. to hill-tops ranging up to 11,000 ft. above sea level. Oak forests which cover the major part of the hill-tops of Kumaon, provide the most suitable habitat. But in late rainy season it is not uncommon to find them even in the pine forest, orchards, grassy meadows, and even in cultivated paddy fields, adjacent to the oak forests. It has been noticed that they are totally absent from some parts of the forests, particularly forests on the southern aspects of the hills and heavily colonise some and are scanty in other parts of the northern aspect of the hill.

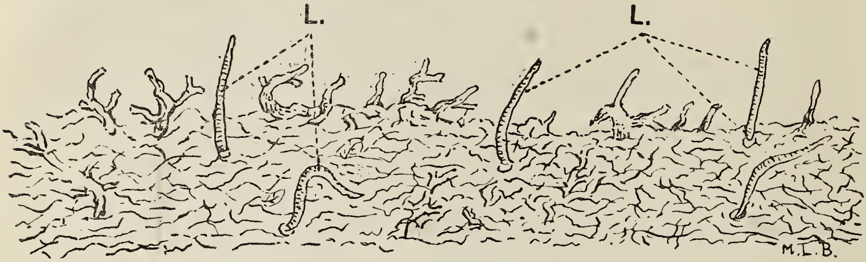


Fig. 1. A few leeches camouflaged in their natural habitat. L. leeches.

Leeches are primarily aquatic and have secondarily acquired life on land. Humidity remains their prime requirement for survival. The role of temperature is also significant as they are limited to a temperature between 10° and 25°C.

The extensive forests in the second and third climatic belt of Kumaon region, provide suitable conditions to these creatures. At elevations between 5000 and 11,000 ft. the rains during the monsoon are fairly heavy. In the second belt the average rainfall is 70″ to 120″, while in the third belt it is 40″ to 80″, of which eighty per cent falls during the rainy season. The forests are dense and evergreen on the northern face of the hill and thin on the southern side. The oak forests have luxuriant under-growth and the trees are draped in a rich epiphytic flora of ferns, mosses, and lichens. Other common trees in the oak forests are ‘ Brunch ’ (*Rhododendron*), ‘ Ringal ’ (*Arundinaria*), ‘ Kaphal ’ (*Myrica*), and a few species of *Berberis*, all with broad evergreen leaves.

The oak forests with this kind of luxuriant vegetation and with a rainfall of over 70″, has high humidity during the rainy season and even otherwise. The average maximum temperature does not rise above 26°C. These two major factors coupled with a few other attributes of the oak forests, such as the shade under the broad-leaved, evergreen trees help in maintaining moisture. The greater water retaining capacity keeps the valleys humid during the hibernation period. The carpet of dead oak leaves on the ground provides shelter during temporary dry spells and checks surface evaporation and the luxuriant under-growth that keeps the forest humid and provides a substratum for their movements. All these provide ideal ecological conditions for leeches. An additional advantage is the fire resisting qualities of oak forests that have saved leeches from total eradication.

The density of leech population varies much in different parts of the forest, due to several factors that influence the habitat. Dense forests on the north facing slopes provide a much more suitable habitat than the forests on the southern side, which are very sunny and almost bare, comparatively warm, and less moist and sometimes quite dry. It is interesting to note that human agency has influenced to some extent the colonisation by leeches, and densely infested leech localities are always found near the grazing grounds and human habitation.

Leeches found in other places, like orchards, meadows, paddy fields and open patches of land during the rains, are actually migrants from the main oak forests. There is evidence to support the fact that they do not really emerge in these parts; that they migrate to all these localities after their emergence in the oak forests. They are seen in these parts quite late in the season and they also disappear early. Leeches do not permanently colonise these areas due to unfavourable conditions, particularly during the hibernation period.

During the rains, they are also found in the neighbouring xerophytic pine forests which have the same altitudinal range, but are really migrants from adjacent oak forests. Certain mixed type of forests, along with ravines which have a large number of oak trees, are very heavily colonised. Leeches have not successfully colonised pine forest because of xerophytic conditions, lack of undergrowth, the disagreeable and repelling smell of resin, and the absence of suitable shelter among the needle-shaped pine leaves. To all these may be added prevalence of fire.

Although between 7000 and 9000 ft. altitude there are different types of forests in the same altitudinal range and with almost similar conditions of shade and temperature as those in oak forests, it is surprising to note that leeches do not inhabit these forests. Viewing the general conditions of these forests of Blue pine (*Pinus excelsa*, 6000 ft. to 8000 ft.); Spruce (*Picea norinda*, 7000 ft. to 9000 ft.); Cypress (*Cupressus torulosa*, 6500 ft. to 9500 ft.); and Deodar (*Cedrus deodara*, 8000 ft. to 10,000 ft.); it seems that the meagre rainfall (10″ to 40″), needle-shaped leaves, scarce under-growth and lack of hibernating grounds have completely checked the infestation of these forests.

FOOD

Land leeches are blood-sucking ectoparasites and they are remarkably adept at taking from the host very considerable quantity of blood without being noticed. In natural conditions it has been observed that they feed infrequently but take large quantities of blood at one time, over ten times its own weight. Digestion and absorption are very slow processes, and it takes nearly 8 to 10 months to assimilate a full blood-meal.

Smythies (1953) raised the question, whether land leeches feed only on blood or could also subsist on other food materials, such as humus and plant-juices etc. Harrison (1953) believes that they feed exclusively on blood, and we fully endorse this view. Hungry leeches kept in cages, containing humus, oak leaves, succulent herbs, and a few common invertebrate forms (earthworms, some arthropods, and slugs etc.) that are commonly found in leech localities, remained untouched by leeches and they starved and did not survive. On the other hand leeches fed on blood grow well and survive up to the hibernation period. It has been possible to keep leeches for more than three years by providing them a single blood-meal every year, with suitable conditions of temperature and moisture.

It is a well established fact that leeches feed on blood and blood only, but the information regarding the favourite victim is very meagre and it is also not known whether all the leeches are able to procure at least a single blood-meal. They rely for their nourishment on their ability to make contact with vertebrate hosts capable of rapid movement. The common vertebrates inhabiting the forests of Kumaon, like Barking Deer (*Muntiacus muntjak*); Goral (*Nemorhaedus goral*); Sambar (*Cervus unicolor*); Rhesus Monkey (*Macaca mulatta*); Langur (*Presbytis entellus*); and Serow (*Capricornis sumatraensis*), are all attacked by leeches. Birds are not usually attacked. Some birds (Kaleej and Koklas pheasants) were shot in the leech-infested areas during the rainy season and a few leeches were found on their tarsus, but there were no signs of previous bites by leeches on any of the birds to indicate that they had frequent leech attacks.

A number of species of rats, and moles exist in the oak forests, which become their victim. But leeches kept with the common rat (*Rattus rattus*) in a cage in the laboratory, did not touch the rats.

Moore (1927) refers to a freshwater crab (*Potamon atkinsonianum*) as a specific host of the leech *Haemadipsa sylvestris*. The only large invertebrate slug (*Limax*), common in leech localities in Kumaon, is not attacked by these leeches.

Kinloch (1922) reported a leech attacking *Dryophis*, an arboreal species of snake, in a coffee plantation at Nelliampathy hills in south India.

Moore (1927) reports to have received specimens of land-leeches collected from the local frogs of Ceylon. A large number of toads

(*Bufo melanostictus*) very commonly seen in the same locality during the rainy season, were found free from leeches.

The present study of leech habitats and the wide range of victims they come across gives the impression that leeches do not get frequent opportunity of securing a meal. Large wild animals capable of rapid movement usually abandon heavily infested areas, while rodents with their dense fur-coat and birds on account of feathers do not offer much chance of a meal to leeches. We feel that domestic animals are the main source of their subsistence. It has been noticed that some wild animals and cattle are their primary victims. The colonisation of grazing lands, cattle tracks and the areas near human habitat, support the above view. On cattle that daily visit or only pass through these areas for grazing, it is a common sight to find at least eight to ten leeches sticking in between their hooves and bare parts of the body, particularly the nasal and genital regions.

It has long been queried whether the entire leech population is able to secure a meal. In this connection it is worth noting that the reported abundance of leeches by previous workers appears to be an exaggeration. In fact the fear and annoyance caused by these agile creatures have probably led workers in the past to over-estimate their population. The same view has been expressed by Moore (1932) who made observations on land leeches in this country. Harrison (1953) made an attempt to give an approximate estimate of leech population. His figures seem quite reasonable but we feel that wild-stock alone, at least in the Kumaon, is not sufficient to provide meal to most of the leeches. During the present study an attempt was made to calculate the approximate density and leech population in different localities in Kumaon hills, and worked out as 4 leeches per square metre. According to this, a total land area of 10,000 square metres would have an approximate leech population of about 40,000 individuals. Considering the average number of leeches attacking per cattle (4 leeches to an animal) and number of cattle grazing in leech infested areas (100 animals a day); it could be estimated that most of the leech population is able to get at least one meal in an active season of approximately 100 days.

COPULATION

Land leeches, like other members of the group, are hermaphrodites. Reciprocal cross-fertilization takes place by the union of two individuals. The process of copulation in land leeches was observed in nature by Leslie (1951) and Harrison (1953). Leeches usually copulate in the month of April and it has been possible to watch the process in field and also in the laboratory.

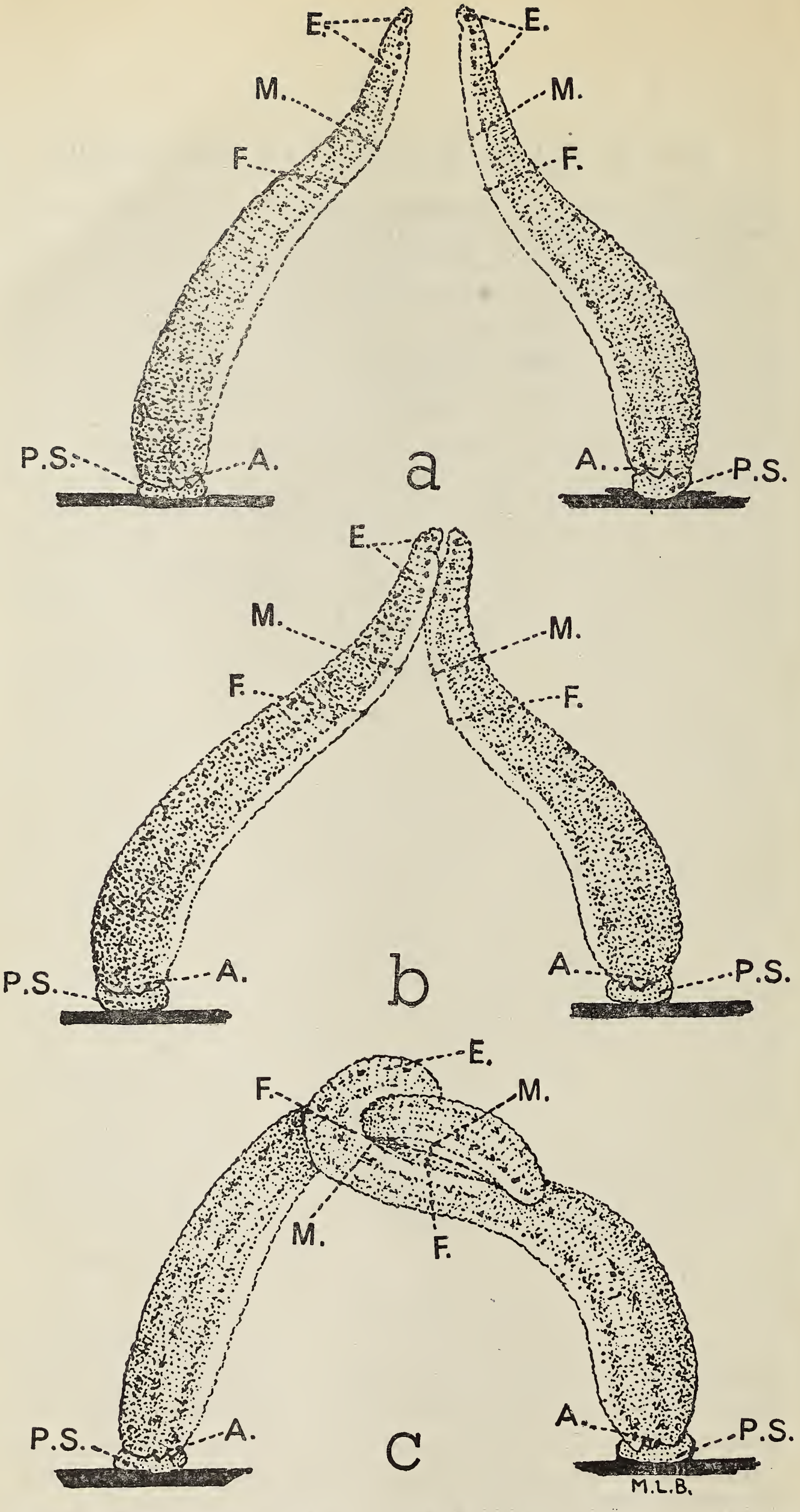


Fig. 2. Sketches showing different postures, leading to copulation. a. Pre-copulation posture, with the posterior suckers of both the leeches attached to the substratum, and body standing erect. b. Close contact of the pre-clitellar portions of the two worms. c. Copulating posture: anterior portion of one curves round the anterior portion of the other, entwined in a head to tail position. Both slightly raised from the ground in the form of an arc. The male genital pore of the one is opposed to the female aperture of the other and vice-versa. A. auricle; E. eyes; F. female genital aperture; M. male genital aperture; P.S. posterior sucker.

Leeches move about in different directions, and when two full-grown leeches meet head to head for a short while, they fix their posterior suckers on to the substratum and sway their bodies till they touch each other. The act of swaying and a sort of embracing action of the two, taking place before the actual process of copulation was termed by Leslie as ‘Dance’ which lasts for a few minutes. Such casual contacts between the two leeches are not of much significance in the beginning as leeches often come close together, touch each other and separate. In cases where such meeting leads to actual copulation the animals after some preliminary muzzling establish close contact. With the posterior suckers firmly fixed to the substratum, the anterior portion, up to the clitellar region of one curves round the anterior portion of the other, in a head to tail position. The part of both that are in close contact get slightly raised from the ground and assume the shape of an arc. The ventral side particularly the clitellar region gets slightly flattened. In this posture the male genital pore of one is opposed to the female aperture of the other and vice-versa. Both remain in this position almost motionless for some time, except for a continuous slight swaying backwards and forwards. This is followed by alternate pressing movements of both leeches, by which the clitellar regions of both get further flattened and develop still closer contact. At this stage the male organs of both project, as was observed and recorded by Leslie, and transference of seminal fluid takes place in a reciprocal manner.

During the process of copulation a whitish jelly-like lubricant material, probably secretion of the prostate or more likely of the clitellar glands, is seen in between the surfaces of the two worms that are in close contact, which becomes more evident when they separate after the copulation. Soon after the process the posterior suckers get detached and the leeches start moving the usual way.

In several copulating individuals it has been possible to watch the entire process and to record the total period involved in the act. Beginning from their coming in close contact, to actual copulation and separation, the time involved ranges from 40 to 65 minutes. Leslie records ‘Dance’ for about 2 minutes and actual process lasting for one and a half minutes. Harrison’s note on sexual behaviour of leeches, leading to copulation, and the figure given by him show the posture prior to actual copulation, which he observed lasting for an hour and a half. Actual copulation takes place only after the male orifices get opposed to the female apertures, a position not achieved in the figure given by Harrison, which depicts only close contact of the two worms. He therefore missed this important point in his observation.

COCOON FORMATION

Leeches that have successfully mated lay cocoons, generally in the months of May and June and sometimes even in July. During these months the clitellar region (segments IX, X, and XI) becomes slightly depigmented owing to the presence of large number of epidermal clitellar glands, and it becomes slightly yellow in colour. The cocoon laying process is almost similar to that in other members of the group described by Khan (1912), Matthai (1921) and Bhatia in HIRUDINARIA (1941). Just before the actual process of cocoon laying, the leech becomes sluggish and settles down at some shady place, free from any kind of disturbance. A copious secretion of several layers of snow-white froth, secreted by the glands of clitellum, appears all round the clitellar region in the form of a girdle. During the formation of the frothy material the front portion of the leech, up to the clitellum, shows a slow rolling, as well as dorsoventral movement, while the post-clitellar portion of the body exhibits no movement. Formation of the frothy girdle takes about an hour. After that, large quantity of albumen, and fertilized ova extruded through the female generative aperture pass into the frothy girdle. By rhythmic movements, the leech withdraws the entire front portion. The plugs at the two poles of the cocoon are secreted by the prostomial glands, as stated by Bhatia (1939). Cocoons are generally laid in well protected shady places. The cocoon formation is a comparatively slow process lasting for about 5 to 6 hours. The froth on exposure to air hardens and forms an outer spongy layer with spacious air cavities in it. Like other leeches, land leech lays successive cocoons after an interval of about 4 days.

COCOON

The cocoon is barrel-shaped and measures 8 to 12 mm in length and 6 to 9 mm in breadth. The cocoon-wall consists of two layers: an outer formed by the hardening of frothy secretion, and an inner chitinous layer. The froth, when fresh in the process of cocoon laying, is in several layers of large bubbles and during hardening process the bubbles unite and form hard partitions, and by pressure acquire a characteristic pentagonal shape. This layer protects the contents from minor shocks and from pressure of oak leaves and other objects under which the cocoons are generally laid. During rains and flooding of the area the air cavities provide buoyancy to the cocoon. The inner layer is quite hard, smooth and tough, and enclosed in it are a mass of albumen and fertilized ova. Both the layers are transparent.

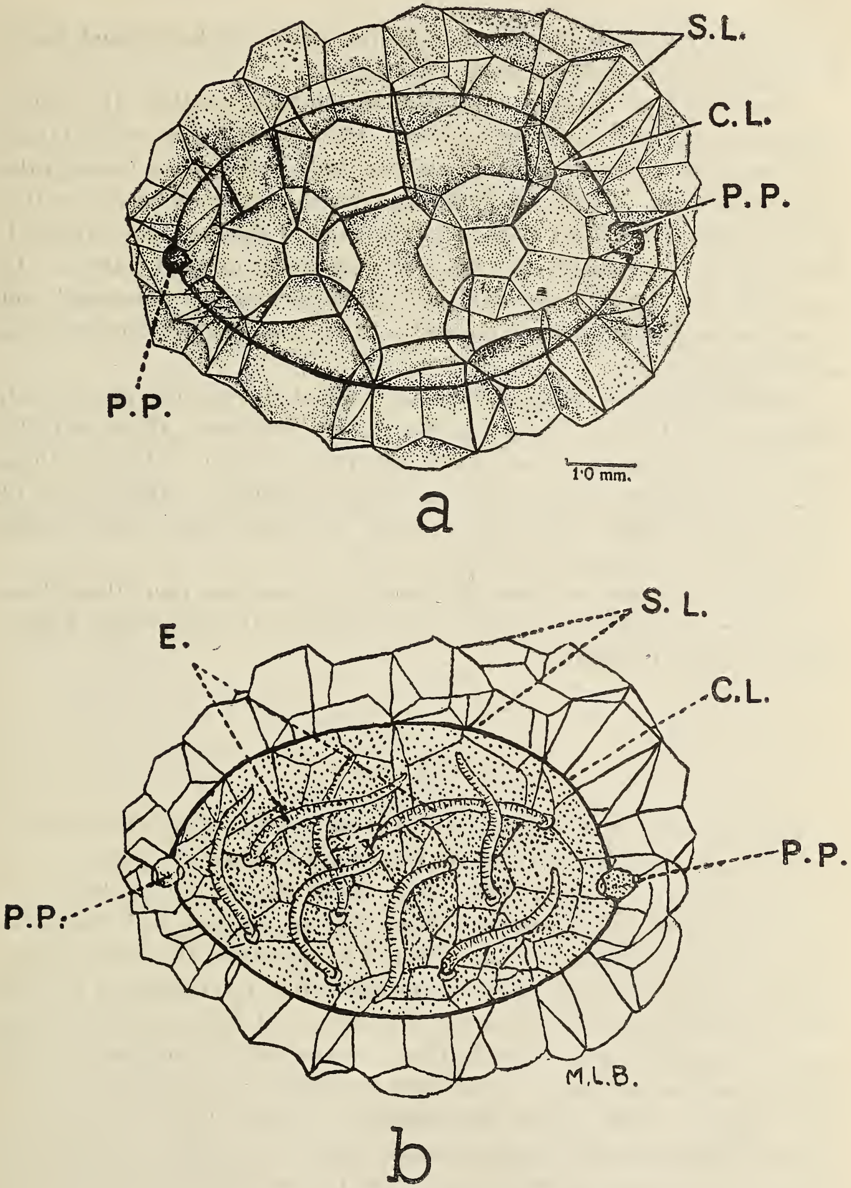

S.L.
C.L.
P.P.
P.P.
1·0 mm.
a
S. L.
E.
C.L.
P.P.
P.P.
M.L.B.
b

Fig. 3. Cocoon

a. Two days' old leech cocoon.

b. Longitudinal section of 18 days old, almost mature cocoon, showing 8 embryos inside it.

C.L. cuticular layer ; E. embryos inside the cocoon ; P.P. polar plugs at the two ends of the cocoon ; S.L. spongy layer.

DEVELOPMENT

There is no larval stage in the life-history of the leech, and entire development is completed inside the cocoon.

Fertilized ova develop into embryos, which swallow the entire albumen contained inside the cocoon. After about 5 days of the laying of cocoon, the embryos are seen making slight movements, through the transparent cocoon wall. 8 or 9 days later the embryos become active inside the cocoon and in about 15 days most of the organs are formed, five pairs of pigmented eyes become prominent in each embryo. In about 20 days typical coloration and pigmentation are developed and development is almost complete and 6 to 9 young leeches emerge from each cocoon.

Freshly emerged young leeches are reddish brown in colour, each measures 5 to 10 mm. Soon after emergence they move about actively, and they remain active throughout the rainy season. Most of these succeed in getting a full meal, and attain maturity. At the close of rains they hibernate and on the onset of next rainy season they again become active, copulate, and lay cocoons.

It has been observed that land leeches survive for more than three years, but further observations are necessary to determine definite period of their life-span.

LIFE-CYCLE

Observations on the life-cycle of land leeches show two distinct phases in their activities, an active phase and a dormant phase.

Active Phase: It generally starts from the month of June and lasts till the end of November. Since the appearance and disappearance of leeches depends on rainfall and temperature, the active phase extends mainly over the monsoon months (July to October). During this period they perform all essential functions of life namely feeding, growth, maturity and reproduction. Soon after emergence from cocoons they actively move about, and spread out over a large area and also migrate uphill. From the middle of July to the third week of August, their activities reach a climax, and by the end of September they start retreating to the valleys. By the middle of October they start hibernating and thus completely disappear.

Dormant Phase: The remaining six months (December to May) constitute the dormant phase or the hibernation period ; but generally leeches disappear completely by November and reappear only by the end of June, thus extending the hibernation period to about eight months.

MIGRATION

Migration or mass movement of land leeches has been a subject of much inquiry for a proper understanding of their ecology and biology.

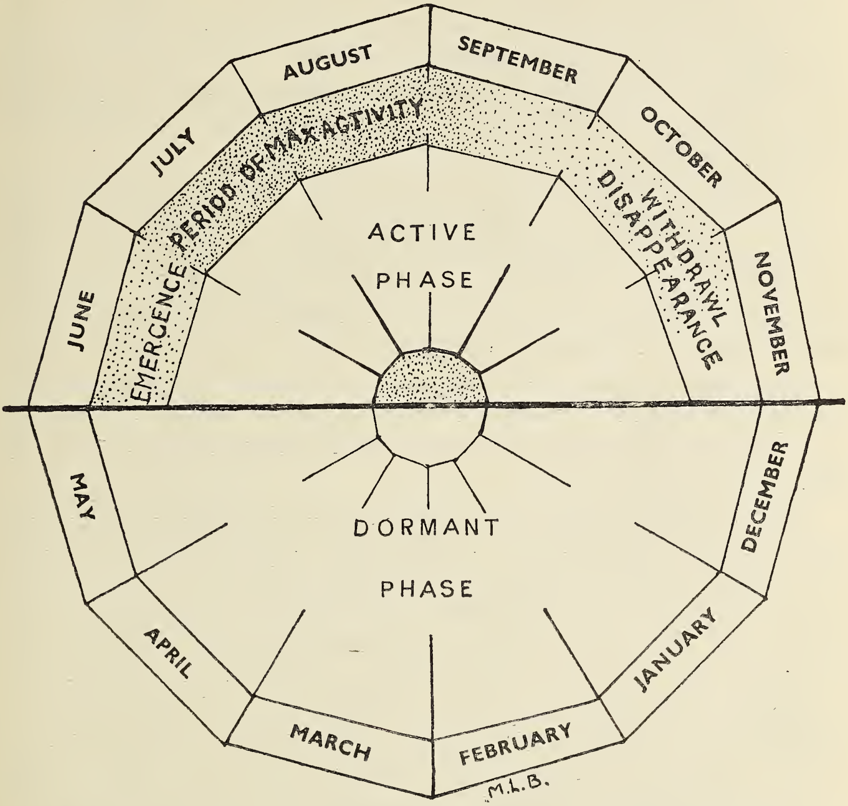

AUGUST
SEPTEMBER
JULY
OCTOBER
PERIOD OF MAX ACTIVITY
WITHDRAWL
DISAPPEARANCE
ACTIVE
PHASE
JUNE
EMERGENCE
NOVEMBER
MAY
DECEMBER
DORMANT
PHASE
APRIL
JANUARY
MARCH
FEBRUARY
M.L.B.

Fig. 4. Diagrammatic representation of the life-cycle of land leeches.

Among annelids the swarming of marine Polychaete worms is a phenomenon correlated with reproduction. In Oligochaeta and Hirudinea such examples are rare.

Moore (1932) has hinted on the seasonal migration in *Haemadipsa sylvestris* and *Haemadipsa zeylanica montivindicis*. In the latter species he describes an altitudinal migration also. Richardson (1942) has reported migratory behaviour in various species of freshwater leeches. In case of *Haemopis marmoratis*, a scavenger freshwater leech, he observed uni-directional advance of half a mile or even more and in *Glossiphonia complanata* he observed a habit akin to swarming.

Land leeches hibernate in valleys during the months November to May. On the advent of the rainy season they emerge and lead an active life, as mentioned earlier, in the humid oak forests of the hills.

The first emergence of leeches as already stated, is in the first week of June, by the sides of dry water courses or nullahs, soon after heavy shower of rain.

The bulk of the population of leeches that emerge at this time consists of leeches of appreciable size, small or even medium size leeches are rarely found at this period. After more rain they become very active and spread throughout the valley, which is still dry. By the middle of June rains become quite a regular feature with frequent heavy showers. Leeches, then, start spreading up towards the northern slopes.

Continuous rain all over the oak forest creates humid and moist conditions sufficient to provide moisture after a prolonged dry spell. The presence of widespread humidity initiates leech migration. By this time the number of leeches is as large as four to six per metre, and medium-sized ones are more in number than the large adults. After about ten days of emergence leeches spread nearly 100 metres up the northern slope. The upward movement during June depends on the weather conditions. If there is continuous rain, the advance is quicker, and their activities slacken to a great extent if there is a prolonged dry spell.

The month of July generally experiences incessant rains and activities of leeches increase in this period. By the second week they are found all over the summit, the cultivated fields and grasslands near the top of the hill, and this is the time when they prove a great menace. A study of the leech population in the middle of July reveals that at the top of the hill leeches of large size, and in the middle region both large and medium-sized are present in considerable number. Freshly emerged young ones form the primary leech population in the valley, though some are seen in the middle region also. By this time large number of cocoons hatch resulting in tremendous increase in the population stock of young leeches in the valley.

By the end of July the number of young ones, in the middle region of the hill, exceeds that in the valley. This is probably due to the emergence of large number of leeches from the cocoons, laid by the migrating leeches in the middle zone and migration of fresh stock of young ones from the valley upwards in search of a meal.

Freshly emerged stock of young leeches reaches the top of the hill by the second week of August and they are most active in their attack on animals and also human population. Observations indicate that from the 2nd week of July to 3rd week of August, the activities of leeches remain at their peak, and as such this period could be regarded as the ‘ Peak period of activity ’. During this period even the xerophytic pine forests are quite moist and leeches are seen advancing to all these places. In such cases the migration is altitudinal, horizontal and even downward. In fact during this period leeches migrate indiscriminately and spread to all possible directions in search of food. In oak forests they start moving upwards from the very beginning and show definite upward trend of migration, much more on the northern slope of the hill. The southern slope which is mostly covered by pine forests, the intervening areas between the xerophytic pines and the evergreen oak forests, are comparatively exposed to sun and are warm and dry. Hence the movement of leeches through such areas is practically impossible till heavy and continuous rains set in.

By the third week of August a downward migration commences, as indicated by the decline of their population at the summit; to such an extent that in the fourth week of August they withdraw altogether from the top of hills and appear to concentrate in the middle region of the hills. It is interesting to note their complete absence from the valley at this time of the season.

Till the middle of September leeches are in great abundance in the middle region but towards the end of September the entire stock, consisting of the adults, medium-sized and the young individuals, get confined to an area of about 80 to 100 metres above the valley.

By the first week of October further descent occurs and they are found very near the valley. At this time they are very sluggish, hide under oak leaves and come out only when induced by disturbances or some sort of vibrations in the surrounding objects. By the second week they disappear from the entire hill and only a few stray specimens are seen up to about 40 ft. above the nullah in the valley. After a few days they disappear altogether.

Thus it is observed that with the advent of rains, leeches emerge in the valley and migrate upwards to half a mile distance. At the close of rainy season they return to similar areas and hibernate till the next rainy season.

CAUSES OF MIGRATION

The region of the valley provides enough moisture to leeches during dry months of winter and summer and the onset of rainy season not only provides favourable conditions for them to emerge, but also moistens the herbage at heights. Leeches emerge just after hibernation and the newly hatched young stock at the valley needs a meal. The herbage and oak leaves on the ground, shady and moist conditions on the northern slope of the hill, provide favourable conditions to them to move about and spread all over the area in search of food. At the close of rainy season the herbage on the heights dries up, therefore they begin to withdraw and migrate back toward the valley which is more moist and constitutes an ideal hibernating ground. Guiding factors for migration are the moisture, temperature and food. The to-and-fro migratory habit of leeches seems to be induced by the combined effects of the following causes:

Upward Migration

(i) Overcrowding, and scanty food supply in the valley.

(ii) With an upward movement of the livestock there are better chances of procuring food uphill.

(iii) Favourable conditions of humidity, temperature, and suitable moving space uphill on the northern slope.

Downward Migration

(i) Decrease in humidity on the top of the hill.

(ii) Availability of favourable hibernating spots at the base of the hill.

HIBERNATION

It has been observed that land leeches suddenly appear with the first shower of rain, gradually increase in number in certain areas, where they prove a great menace and suddenly disappear when cold weather sets in. Much attention was drawn by the old age mystery of their sudden emergence and disappearance. Suggestions on their probable hibernation were made as surmises rather than on any kind of actual field study of the problem. Tennant (1861) expressed surprise on the complete disappearance of leeches during the dry season and their appearance immediately with the coming of rains. Whitman (1886) suggested that 'they merely seek shelter under stones, sticks etc. as they do all times when not actively moving about, and thus protected against complete drying, await favourable conditions of moisture'. But he denied completely the possibility of hibernation except for those which live above the level of the occasional frost and snow.

Landon (1905) believed that land leeches died with the advent of dry season and those which reappeared on its conclusion are a new generation. *Macrobdella decora*, an aquatic American leech, has been reported by Moore (1927) to live in dry ponds during summer. Bhatia (1941) observed the same in the leech *Hirudinaria*. Similarly a little advanced type of 'draught torpidity' has been described in *Ozobranchus* by Oka (1922). On the contrary laboratory observations during the present course of study show that land leeches, once they become dry, are unable to regain activity, as is common with all living forms.

Moore (1927) summing up the previous views comments that leeches probably pass through a condition resembling hibernation. Later

(Moore 1932) suggested that leeches may concentrate in the vicinity of water sources. Recently Smythies (1953) writes, ' in the tropics they are active all the year round, but in a monsoon climate they disappear entirely for about six months, during the dry cold winter. Do they get through this period in the form of eggs or by burrowing into the soil?

Our present observations are in conformity with the view of Moore (1932) and it has been noticed during the course of our field study that:

(i) The first emergence of land leeches, on the onset of rains, is always at the base of the hill, by the sides of dry water channels or nullahs.

(ii) After their emergence they spread all over, generally more towards the upper limits of the hill, and remain active throughout the rains. At the close of rainy season they gradually migrate to the valley and commence vanishing in the similar regions from where they first emerged.

These observations hint at their possible hibernating grounds. A search of the valley in winter months (December and January) reveals that leeches do not hibernate under the layers of decaying oak leaves, sticks etc., as was suggested by Whitman, a possible abode of their hibernation. Instead, it has been found that they hibernate fairly deep down in soft soil. On digging a foot or more deep, below the earth surface and on turning the underground buried stones and pebbles in the vicinity of water channels, a large number of hibernating leeches were everytime obtained, attached to undersurface of the stones.

Observations made during the active phase of leeches suggest that like all other living beings, food, congenial temperature, and moisture, are the primary guiding factors in the life of land leeches. It has been noticed in the laboratory that they can withstand fairly low temperature. Moreover, the subsoil temperature in the valley does not fluctuate beyond a critical limit. Thus, only moisture appears to be the chief influencing factor during the hibernation period.

Several other hibernating places have been suggested by previous workers, i.e., areas by the sides of water streams which are very damp and flooded, but leeches have not been found from any such localities. They do not resort to aquatic habit of any kind during hibernation. It has been confirmed in laboratory that leeches kept partially submerged in water or very near water, do not feel comfortable and immediately try to escape. They do not survive long in water.

The areas in the valley are slightly different from the other parts of the hill slopes. There is always loose layer of coarse sand and pebbles on the surface, under which, there is a mixed layer of humus, clay and sand. Sand and pebbles are brought down from the slopes of hill during heavy rains. Leeches make their way in to the underground sand

and humus through crevices in the upper layer of pebbles. The overlying layer of sand and stones protect leeches from dessication.

The sub-soil in the valley retains moisture and remains damp all the year round and this kind of constant wet conditions are maintained by various factors. In addition to the occasional rains, there is constant occurrence of what may be called the ' sub-soil moisture '. The soil in the oak forests retains comparatively greater amount of rain water. After heavy showers in the rainy season, at the lower levels of the hill there arise underground streams in the form of springs, which become a constant source of water supply to the nullah or water stream flowing at the base of the valley. When these seasonal springs and nullahs dry up in winter and summer, water retained by the roots of the oak trees in the upper limits, percolates through the underground streamlets. The presence of such streamlets is easily revealed by the marshy conditions even in dry season, when digging to a depth of about 1½ ft. in the region of the nullah. Such sub-soil moisture keeps the hibernating places moist throughout the dry season. The surface evaporation of the sub-soil moisture is further cut down by the presence of a large number of evergreen trees and thus chances of drying up of such places are meagre. The selection of such places for hibernating is obvious.

Hibernating Leeches

Hibernating leeches lie in a dormant, contracted, and emaciated condition, attached by both the suckers to the undersurface of stones and other objects. *Haemadipsa montana* remains slightly more dormant than *Haemadipsa zeylanica agilis*, and its brownish or yellowish colour harmonises well with the surroundings to such an extent that sometimes it becomes difficult to spot these out in their hibernating habitat.

The hibernating leeches observed have been generally of large size, some of median size, but none of small size.

Behaviour of Hibernating Leeches:

Hibernating leeches are very sluggish, and they shun light. They do not respond to human breath or even touch. On pressing hard they show slight activity and immediately try to wriggle away and again hide under some nearby object. When submitted to slightly higher temperature than what they have in their natural habitat, they become slightly active, but not as agile as during the rainy season. Such activity lasts only couple of minutes even when the higher temperature is maintained for some time. When both higher temperature and moisture are provided, they become more active than when only temperature is raised. Leeches that become temporarily alert try to escape. They do not respond to light of low intensity, and they respond negatively to strong light. They do not show any tendency to stick to the skin, bite and suck blood.

DISTRIBUTION IN KUMAON

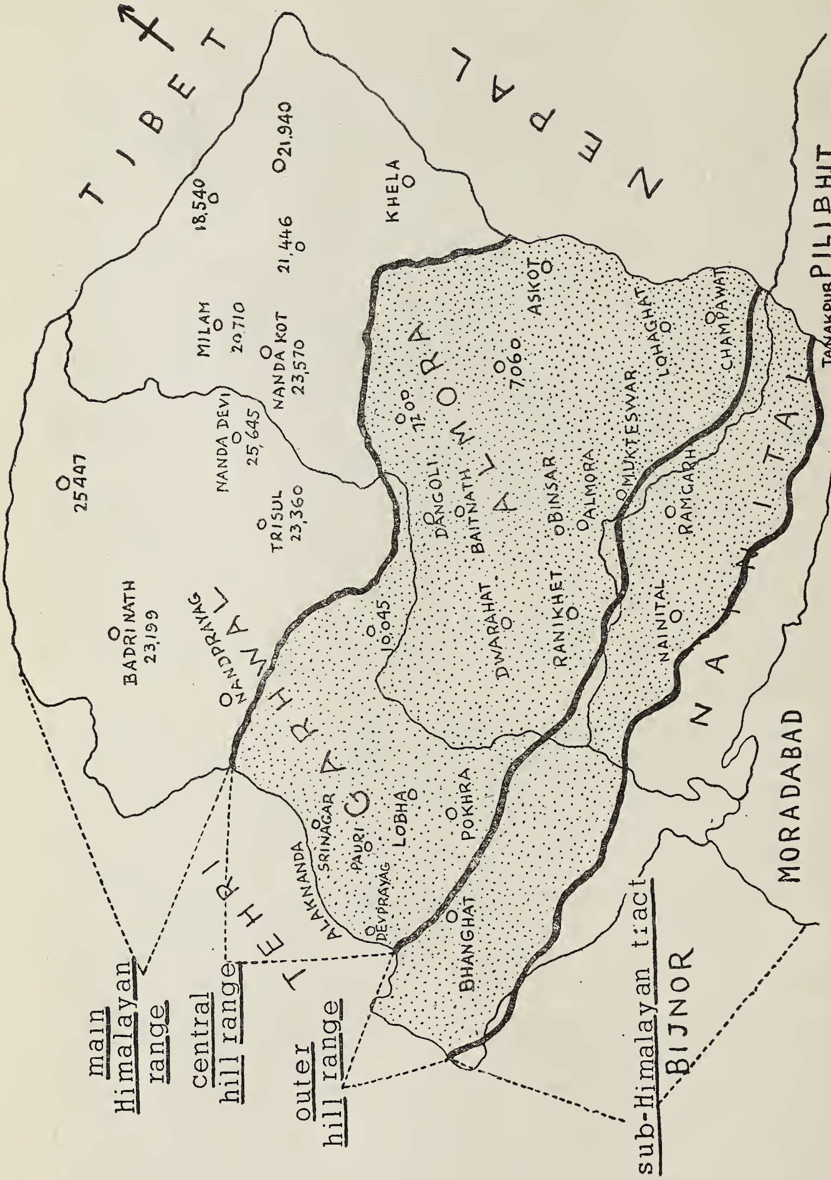
The abundance and ferocity of land leeches have been reported from different parts of India by several naturalists. Haeckel (1883), Hooker (1854), Semper (1863) and others: Moore (1927) casually reported the occurrence of land leeches in Nainital district. As has been mentioned earlier, land leeches are confined only to oak forests, in Kumaon region. A general survey of the climate and vegetation of different regional belts of Kumaon, assists in explaining the distribution of oak forests, which provide suitable habitat to leeches.

The entire Kumaon area may be divided into several climatic belts, running approximately north-west to south-east, parallel to the Himalayas. The division is mainly based on the total rainfall and its relative percentage in winter and monsoon seasons.

I. A regional belt, the 'Sub-Himalayan tract', includes the area running along the foot-hills and consists of Bhaber and Tarai. Rains during monsoon are heavy, 50″ to 70″, and there are extensive forests of Sissu (*Dalbergia sissoo*), Khair (*Acacia catechu*) and Jaman (*Eugenia jambolana*). The maximum average temperature does not fall below 26°C which acts as a major influencing factor for the total absence of leeches from this region.

II. The 'outer hill range' stretches from the base of foot-hills in the region of Kotdwara, Kalagarh, Kathgodam, and Tanakpur, to the crest of the outermost range of the hills of Nainital. The hills rise, 1000 to 2000 ft. at the base and extend up to 4000 to 8000 ft. The general aspect of the hills is southern. Total rainfall ranges from 70″ to 120″ out of which 20% is during winter and 80% during the monsoon months. The dominant forests of Pine (*Pinus longifolia*) between 3000 to 7000 ft. are on the southern side. In pine forests due to xerophytic conditions and prevalence of frequent fire, the undergrowth is very scarce. On higher elevations and by the sides of ravines, the common oak (*Quercus incana*) replaces the pine. These forests are more common on the northern slopes, where the average maximum temperature does not rise beyond 26°C. The oak forests of Nainital district, Kilbery, China forest, Ratighat, Ramgarh, Gagar, Mukteshwar, Paharpani, Okhalkanda, Bhim-tal and Sat-tal etc. continue the upper boundary of this belt, are heavily infested with leeches.

III. Another regional belt, 'the central hill range' includes the vast area of mountainous country stretching to the outermost range of the


TIBET
NEPAL
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BADRI NATH
23,199
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KHELA
MILAM
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NANDA KOT
23,570
NANDA DEVI
25,645
TRISUL
23,360
NANDPRAYAG
GARHWAL
TEHRI
ALAKNANDA
SRINAGAR
PAURI
DEVPRAYAG
LOBHA
POKHRA
BHANGHAT
10,045
ALMORA
DANGOLI
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BAITNATH
DWARAHAT
7060
ASKOT
RANIKHET
BINSAR
ALMORA
MUKTESWAR
LOHAGHAT
CHAMPAWAT
NAINITAL
NAINITAL
RAMGARH
TANAKPUR
PILIBHIT
M.L.B.
MORADABAD
BIJNOR
main Himalayan range
central hill range
outer hill range
sub-Himalayan tract

Fig. 5. Map of Kumaon, showing the topographical divisions and the distribution of land leeches in shaded regions.

main Himalayan peaks. The valleys of the river Sharda, Kosi, Ganga etc. lie at low level between the hills and the temperature is surprisingly high. Main intervening ridges range between 5000 and 10,000 ft. Annual rainfall varies from 40″ to 80″, 70% of which is during the monsoon season. Heaviest rain occurs in the prominent central ranges covered by oak forests (Dudotoli, Bhadkot, Binser, Gageshwar etc.). Most of the area between 3000 and 6000 ft. is covered by extensive pine forests, which is replaced by oak above 6000 ft.

IV. In the main Himalayan range, rainfall is 10″ to 40″ in monsoon, and snow during winter. Banj oak (*Quercus incana*) is commonly found between 6000 and 8000 ft. height but in damp ravines it is represented down to 3000 ft. in the Chir zone. Moru oak (*Quercus dilatata*) is found between 6500 and 9000 ft. and the Kharsu oak (*Quercus semicarpifolia*), between 7500 and 11,500 ft. All these forests are thinly or heavily infested by land leeches. In the upper limits of the Kharsu zone, leeches are very rare. It is possible that on the highest regions of the Kharsu zone which extends up to 11,500 ft. they are absent because of extreme cold.

Some of the heavily infested places in this belt are the oak forests of Shyahi Devi, Sittakhet, Jalna, Mornauli, Debidhura, Panwanaula, Binsar, Jageshwar, Dholchina, Dhakuri, Loharkhet, Kapkot, Attigaon, Munsayari, Kalamuni, Tejam, Karmi, Kanda, Gwaldom, Kaushain, Ranikhet, Dunagiri, etc. in Almora District, and Dharchula, Chandak, Lohaghat, Champawat, Agar, Chhera, Kalsinkatia in Pithoragarh district.

In Garhwal district, Tehsil Deoprayag and Patti Barmabanger are heavily infested and Patti-Sora, Hindab, Silgarh and Mandar are thinly infested.

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Mud and Dung plastering in Baya Nests

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(*With two plates and two text-figures*)

INTRODUCTION

This paper is mainly a discussion on the various explanations that have been offered by earlier investigators on the mud-blobs or dung plastering seen in the egg-chamber of several baya weaverbird nests. Some fresh data on the quantity of the plastering material used in individual nests, stage in the development of the nest when the mud/dung is brought to the nest and the time of the day when the plaster is fixed are furnished. Among the various theories on the mud-blobs, the following in particular have been discussed: for fixing fireflies for illuminating the nest, balancing the nest, protecting the inmates from rain, a relic of an ancient habit, and for cementing the fibre for greater reinforcement of the egg-chamber. The chief function of the plastering materials seems to be the strengthening of the fibre-nest particularly at regions that are subjected to great stress.

One of the best known attributes of the baya weaverbird (*Ploceus philippinus*) that has fascinated villagers for centuries is that based on the mud-blobs found in many of its nests. Nevertheless, observations made on these nests as well as those of the baya's other Asian and African cousins for nearly a century have not highlighted the full significance of the pasty material fixed at specific spots in the nest. A half-built nest of the baya, at what is known as the helmet stage, is divided by a vertical ring into two more or less equal halves. One of these, which is always built a bit ahead of the other, is the future egg-chamber. The other half, known as antechamber, extends downwards into an entrance tube. When the inner walls of the future egg-chamber in such an incomplete nest are examined, one may see on two opposite sides small or large quantities of mud-blobs, or a plastering of clay, cattle dung or in rare cases, human faeces. There is considerable variation in the quantity and quality of the plaster between nests, some not having any of these extraneous materials at all. A few explanations have been offered by ornithologists on the significance of the plaster. Apart from them, the most classical and romantic one based on poetic imagination is that it holds fireflies in order to illuminate the nest at night. Every second villager who is familiar with the baya is likely to vouch emphatically for this explanation although none of them has actually seen a firefly fixed inside the nest. Some naturalists contend that the mud is used to stabilise the nest during gales, while others regard the mud as a relic of some ancient custom at one time beneficial to the species. Other explanations offered are: the mud protects the inmates from getting soaked in rain; prevents the nest robbers from pulling apart the initial ring, and when dry helps to sharpen the beak of the builder.

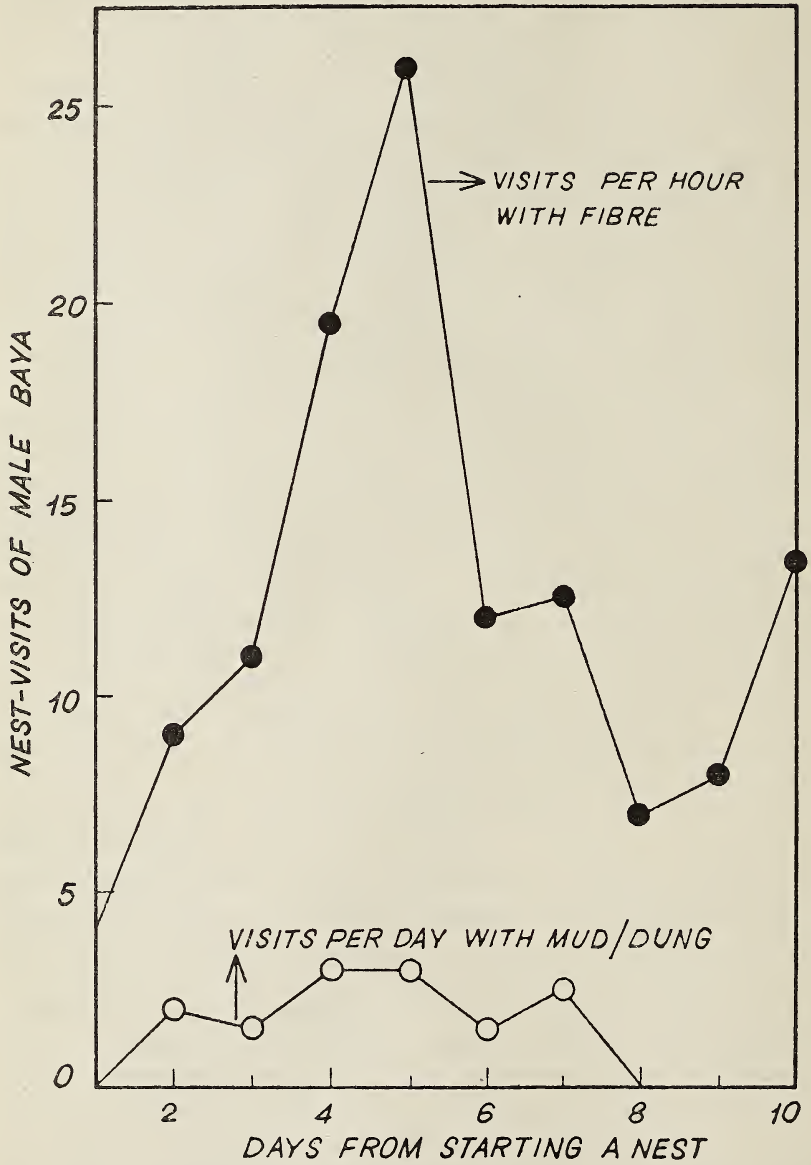
My interest in the common weaverbird was aroused in my early childhood (some 45 years ago) by a large colony that used to nest year after year in our small coconut garden surrounded by paddy fields in the southernmost district of India (Kanyakumari). As pulling down active baya nests having eggs or fledgelings was forbidden, I used to be contented to play with the nests that were periodically cut down by some male birds during the breeding season, and the innumerable ones gathered during non-breeding season. It was at this period that I saw for the first time mud-blobs fixed inside the nest and learned of the universally believed myth of the bird's alleged faculty of illuminating its nest. During the past eight years, the lost thread was taken up again and I could visit many tracts in almost all Indian States and make detailed observations on the variation in the baya nests between different pockets in various regions. With my observations together with what has already been recorded, I venture to make the following comments on the significance of the mud-blobs. Before doing so, some of my observations are presented.

PRESENTATION OF DATA

Loads of mud/dung per nest

Detailed observations on the weaving of a few baya nests were made in 1963 on a colony founded on a palmyra palm (*Borassus flabellifer*) at the northern border of Calcutta. The observations on the activities of the selected birds were recorded from the commencement of their day's work starting from about 5-00 a.m. upto their retirement at about 6-30 p.m. The starting and closing up of the activities in a day depended largely on the intensity of daylight. Records on the number and duration of nest-visits of the cock with or without fibre/mud ; number of visits the hen made while selecting a nest, during brooding a clutch of eggs, and nursing the nestlings; kind of fibre brought and the region of the nest into which they were woven ; pilfering of fibre ; fights between cocks; and the behaviour of the cock and hen during courtship etc. were maintained. Hence I can say with some confidence when exactly the bird brought the plastering material while constructing the nest. In Text-fig. 1, the number of loads of mud and dung fixed during a day (average for four nests watched throughout their construction) are shown.

Crook (1964), a prodigious worker on weaverbirds, has given a detailed description of the nest-construction by baya weaverbird. He mentioned seven distinct stages—formation of an initial wad; wad with horns or cone; initial ring; helmet stage; padded helmet stage; completed nest; and construction after completion. Most of the cocks that I observed nesting on palm leaves started attaching the initial wad in the morning and completed the formation of the ring before dusk. On the second day, porches developed on either side of the ring, and the side that eventually became the egg-chamber grew much faster than the other. On this very second day, the male started bringing loads of mud or cattle dung and fixed them inside the nest. Though the colony I was watching was within city limits, the host palm was standing in a small neglected paddock, a site for a future factory. Within two metres from the base of this tree there was a shallow pond, a perennial source of water where buffaloes wallowed and cropped up the water hyacinth that overgrew the pond. Practically the whole day the buffaloes laid loose dung on the paddock and the birds took beakfuls of this fresh loose paste. The bayas of this particular colony seemed to prefer dung although mud was abundant on the edges of the pond. Moreover, this paddock, overgrown with *Cassia tora* and similar annual weeds, was used as an open latrine by the children of a few shacks bordering the paddock. At least one of the bayas also brought two loads of faeces in a day for plastering the egg-chamber. On an average, a male baya brought one to six loads of the paste per day from the second to the seventh day of founding the nest. At the end of this period, the nest had only reached the padded helmet stage, and the egg-chamber was yet to be completed. A glance at the graph relating to the nest visits of the male with fibre (Text-fig. 1) will confirm this point. Since on the first day the cock struggled to attach the initial wad for making the vital foundation for the nest, on this day he brought fibre only at the rate of four loads per hour (average for a 14-hour day). With the formation of the foundation, the rate of bringing fibre increased, and on the fifth day he brought at the maximum rate of 27 loads per hour. Towards the close of this day the nest attained the helmet stage. From the sixth day, the cock's building activity began declining, for, henceforth he appeared more interested in courting a hen and enticing her to select his nest and thus have him as her future mate. This period of courtship continued up to the eighth day; then, obviously, with the acceptance of the nest by a hen, he resumed active nest-building to complete the egg-chamber which is indicated by the upward trend of the graph. It is quite obvious from the graph that no load of mud (or dung) was brought once a female had approved and accepted the nest. The hen was never found bringing mud or dung.



Text-fig. 1. Nest-visits of baya cock with fibre (per hour) and mud/dung (per day).

On an average, each of the four males observed brought 12·5 loads of mud during a six-day period. However, in general, the number of loads per nest varied very greatly between nests of the same locality and between localities. Examination of 3 to 25 nests from different regions (or States) indicated that not all nests have mud plastering, but practically in every locality there are a few to a large number of nests, each containing one to about twenty loads of the plastering material. The quantity of mud (or dung) in a nest varied according to the quality of the weaving material used, and also depended on whether the nest was woven explicitly or shabbily.

Time of bringing mud/dung

The male baya starts collecting fibre and weaving them just after 5 a.m., and within an hour he goes for the mud or dung. The earliest I noticed a bird bringing mud was at 5.33 a.m., and the visits extended during the day at irregular intervals up to 4.50 in the evening. However, all visits excepting a single one were finished before 2 p.m. As most of the time I was observing the colony in Calcutta, I was comfortably perched on a 6-metre high machan, I was able to make note of the males during each of their almost vertically downward flights in search of mud or dung. When they flew to bring fibre or left for foraging or to the roost, the males always took a horizontal flight that was strikingly different from that when they went in search of mud/dung. Even without field glasses, I could clearly observe the male collecting the paste. During most of their trips a majority of the birds preferred to collect wet dung although mud of a similar consistency was available in close vicinity on the sides of the pond. While collecting the mud/dung, the bird inserts its bill slantingly and scoops out beakfuls. I have never seen the bird stirring or mixing the mud/dung either with its feet or beak. However, once or twice I noticed the bird making a second or even a third scoop at a stretch to collect the required quantity. Only fresh dung was used in all cases since after four or five hours a dung heap dries up and consequently it becomes harder for the bird to scoop out a small quantity from it.

Another point that struck me was the way groups of males went to collect mud/dung almost simultaneously. Table 1 gives information on the time of bringing mud/dung by two males building nests of almost similar stage close to each other on a palm. The group collection of mud was so striking that my attention was drawn to that even when the birds I was watching did not participate at it.

Either at the collection centre or on their way, the males seldom fight or spend time in fruitless conflicts. Usually, within 30 seconds of leaving the nest, the bird brings a load of mud/dung to the nest. So far I have never noticed pilfering of clay/dung from other nests although pilfering of fibre is part of the nesting activity in the case of most males. Some are more proficient than the others in the clandestine act.

TABLE 1

Ploceus philippinus : DATA ON NUMBER OF MUD/DUNG LOADS BROUGHT IN TWO NESTS

Hour	Minute	Nest I		Nest II		Remarks
		Mud	Dung	Dung	Mud	
April 29, 1963						Activity commenced at 5·03 hrs.
5	48·5	..	1	..	..	
5	49·5	..	1	..	..	
5	51	..	1	..	..	Dung was collected from the paddock near the pond.
8	30	..	1	..	..	
12	53	..	..	1	..	
12	54	..	..	..	..	7 others gathered mud.
12	55	1	..	..	..	
12	57	1	..	..	..	7 others gathered dung.
13	26	..	..	..	..	4 others gathered dung.
13	53	..	..	..	..	3 others gathered dung.
April 30, 1963						
5	43·5	..	..	1	..	
5	45	..	..	1	..	
6	34	1	..	..	..	
6	34·5	1	..	..	..	
8	23	1	..	..	..	
8	38·5	..	..	1	..	
8	39·5	..	..	..	1	
8	58	1	..	..	..	
11	36	..	..	..	..	Many others gathered dung.
12	07	..	..	1	..	
12	40	..	..	1	..	
13	49	..	..	1	..	
16	50	1	..	..	..	
May 1, 1963						
5	33	..	1	..	..	Mud was always collected from the side of the pond.
7	25·5	..	1	..	..	
7	28	..	1	..	..	
11	00	..	..	..	1	
11	02	1	..	..	..	
11	04	1	..	..	..	
13	51	1	..	..	..	Activity terminated at 18·15 hours.

N.B.—Foundations for nests I and II were made on April 28, and no mud/dung was brought to the nests on that day.

Weight of mud/dung loads

I could not weigh the fresh mud/dung used by a bird. Weighing the dry material collected from nests, in some cases several months after their fixing, may not reveal the exact situation. Nevertheless, the data suitably adjusted for the moisture content may give some idea of the total weight of the materials used in a nest. Approximate percentages of moisture content in mud and dung have been calculated by weighing known quantities of fresh mud and dung collected from the same localities and getting their weights after drying them. The figures (in gm) are as follows :

Material	Wet weight	Dry weight	Moisture percentage
Mud	113·3	66·2	41·57 on wet weight
Dung	144·0	20·2	85·97 on wet weight

Thus, fresh mud weighs a little less than twice the dry mud, but wet dung weighs a little over seven times the weight of dry dung.

Figures 1-3 (Plate I & II) show views of mud or dung patches in four nests. Where abundant quantities of the mud/dung are used, they are generally dumped into a thick lump or coating. Hence by examining a patch it is often difficult to estimate the number of loads of the material used in such a patch, especially if it is dung plastering (Plate I, Fig. 2, and Plate II, Fig. 3). However, where the nests have smaller quantities of mud, it is possible to estimate the number of loads more or less accurately (Plate I, Fig. 1). It is still more easy if the mud-blobs are sparsely fixed. Another factor that helps in the identification of individual loads is the variation in the shades of colour of the different loads. In some other cases mud blobs alternate with dung (Plate II, Fig. 3). Faeces plastering is distinctly different from

TABLE 2

Ploceus philippinus: NUMBER OF LOADS AND WEIGHT OF MUD IN NESTS

Kind of fibre used in nest	Mud or dung	Wt. in gm. of plaster on side			Calculated wet wt.	Approx. No. of loads
		Left	Right	Total		
1. Sugarcane leaf	mud	3·09	7·36	10·45	17·87	7+17
2. Sugarcane ,,	mud	7·05	5·56	12·61	21·56	16+12
3. Wild cane ,,	mud	9·66	16·98	26·64	45·55	17+22
4. Sugarcane ,,	mud	1·34	7·53	8·87	15·17	4+21
5. Wild cane ,,	mud	2·48	7·58	10·06	17·20	6+16
6. Ordinary grass	mud	9·84	11·92	21·76	37·21	20+26
7. Rice leaf	dung	2·72	nil	2·72	19·39	9+nil
8. Rice leaf	dung	6·30	0·44	6·74	48·06	30+ 6
9. Ordinary grass	mud	13·86	7·64	21·50	36·77	22+15
10. Ordinary grass	mud & dung	8·68	8·99	17·67	78·10	22+26
11. Rice leaf	mud	35·30	..	35·30*	60·36*	72+ 0*

N.B.—*The figures relate to mud blobs present on only one side. That present on the other side was ignored as portion of it was lost while collecting.

Nest 10 had about equal quantities by dry weight of mud and dung.

the rest. It is on the basis of the above facts that the weight of a single load of mud/dung has been calculated. Table 2 gives data on the weight and number of loads of mud/dung used in individual nests.

It appears as though the weight of a single load of mud/dung varies from region to region, although the mean weight works out to be about one gramme. Where smaller numbers of loads are used, as in nests from southern and western India, the loads seem to be heavier than those seen in North-eastern India. The bird usually carries a load that is maximum for its capacity and since he has to make a steep ascent with the load to reach the nest, he often showed visible signs of strain. On windy days, I noticed some males carrying mud to the nest were tossed away to adjoining leaves. During two such occasions, the birds abandoned the mud/dung and flew for safety.

The mud/dung is fixed very firmly on the inner wall of the nest so that it is impossible to pull away the dry plaster without breaking the fibre. Since the bird effectively spreads the sticky material with his beak, beak marks are seen on the surface of the paste which are more clear on mud-blobs (Plate I, Fig. 1). Often fresh fibre is woven so as to cover part of the plaster (Plate I, Fig. 2).

Plastering in ' Bachelor nest '

The helmet-stage nest is also spoken of as ' bachelor nest ' since up to this stage it has been owned and used during the day time only by the male (builder) who is yet to acquire a mate. If no female selects a nest for a long time, such a nest is either cut down by the builder himself, or more frequently, it is lengthened unusually with a droll look, still maintaining the two openings. It is more appropriate to consider only such nests as ' bachelor nests '. The body of some such nests measures three or even four times longer than that of a nest built by an efficient male and accepted fairly soon by a hen. The initial ring in such abnormal nest gets shifted downwards since the inner dome is also proportionally filled up as the nest grows (Davis 1971). It is rather difficult to explain the presence of mud in some ' bachelor nests ' since most others do not have mud. An important reason for a nest to get rejected by females in the normal breeding colony seems to be that it is probably not strong enough to withstand the force of wind. Not only such clumsy and weak nests, but also the wrongly aligned ones are discarded by the hens. Most of these droll looking elongated nests do not have any mud/dung plastering at all. However, in a limited number of them, a maximum possible quantity of mud was seen. While dissecting out one of the nests, mud coating was noticed over a length of 25 cm. on two opposite sides of the portion meant for the egg-chamber. Obviously, most of the mud coating was covered with fibre because the ceiling of the dome was gradually lowered as the bridge extended downward. Even in such a nest, not even a single blob of mud was seen on the wall of the antechamber.

Discussion

Mud/dung present only on one side of ring

Even when the nest of baya weaverbird is incomplete, the birds enter the nest through the opening of the antechamber and perch on the bridge (lower part of the initial ring), facing the future egg-chamber. According to Collias & Collias (1962), this situation is remarkably applicable to the African village weaverbird (*Textor cucullatus*) which almost always enters the nest from one side and faces the same way, keeping one foot on each side of the bottom of the ring. Perching on the ring, the baya fixes some mud/dung on the wall of only the egg-chamber, usually in two patches, one to the left and the other to the right which happens to be the most convenient places as the bird does not reverse the direction of its perch. So far as the initial ring is concerned these two patches fall only on one side (egg-chamber side). But usually it is stated that mud-blobs are fixed on the two sides of the initial ring.

The firefly story

The purpose of the mud/dung seen inside the nest is certainly not to hold fireflies to illuminate the nest at night. According to Dewar (1909) and Ali (1931), this story is nothing more than a poetic exaggeration. This is a form of exaggerated eulogy by those who have been fascinated by the sagacity of the tiny bird who weaves an exquisite pendant nest. My observations throw further light on two additional points which would disprove this myth. From graph (Text-fig. 1), it is clear that the mud/dung is brought between the second and seventh day of building the nest, at a period when the nest has not reached beyond the helmet stage. It is an established fact that the builders do not spend the nights inside their nests, but they get back to the usual roosts. Moreover, at this stage the nest has not yet been chosen and occupied by a female. Therefore, the ' wet fittings ' and the ' bedroom lamps ' become meaningless in a vacant house. If at all illuminating the brood-chamber is justified, it should be after the hen starts to brood, and more so, when the mother is with fledglings. The other point is based on the information given in Table 1. The timings of bringing the cementing material clearly prove that the mud/dung is not meant for burying the heads of fireflies. Most of the plastering material is carried to the nest between 5-30 a.m. and 2-00 p.m. and by dusk, it becomes too dry and brittle to accommodate an insect. In none of the over one hundred nests I have examined, there was any firefly fixed to the mud—not even a head. None of my students and associates who once believed in the myth, could convince me by bringing a nest bearing a firefly. Although beak marks are clearly seen on the dried up mud (Plate I, Fig. 1), they did not resemble the impressions caused by the burying of an insect.

Balancing the nest

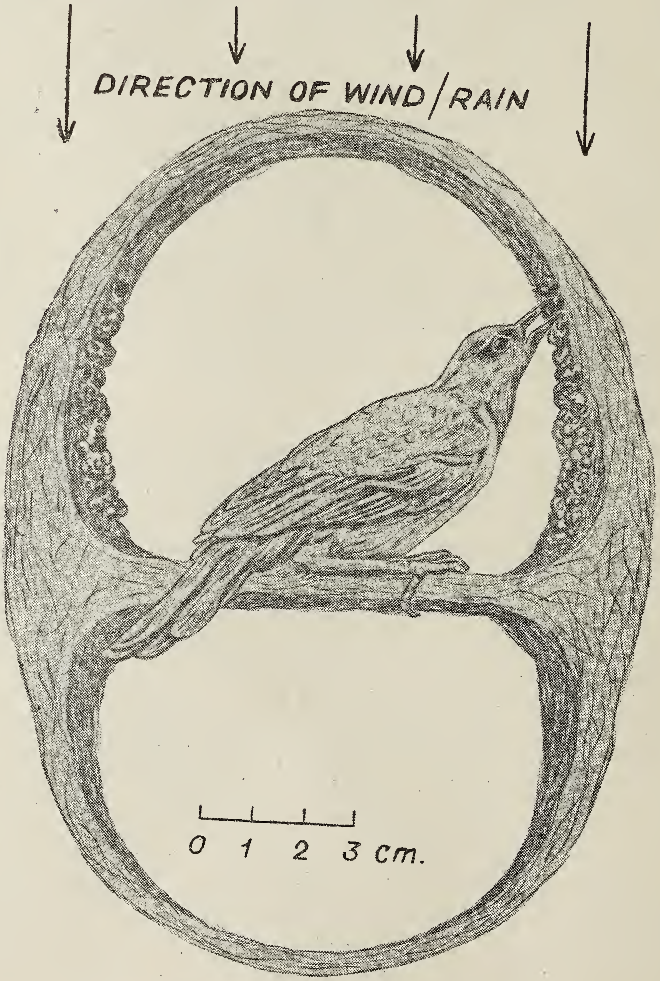
Jerdon (1863), who was one of the earliest to describe the baya, mentioned the significance of mud-blobs thus: 'From an observation of several nests, the time at which the clay was placed in the nests, and the position occupied, I am inclined to think that it is used to balance the nest correctly, and to prevent it being blown about by the wind. In one nest lately examined, there was about three ounces of clay in six different patches.' Jerdon also believed that the pieces of clay are more commonly found in the unfinished nests (built by the males for his own special behoof) than in the complete nests. Ali (1931) reacted sharply to Jerdon's explanation of the mud being used for steadying the nest during violent winds. Ali did not come across in any of the over fifty nests examined by him, mud weighing more than 1·4 oz. and so he concluded that this insignificant extra weight could not keep the nest steady during violent winds. Usually in the same colony there are many nests which do not possess any mud at all, but having equal survival value like those with mud-blobs. The oropendolas (*Zarhynchus wagleri*) with long woven pendent nests do not provide any 'balancing material' against violent trade winds. Crook (1963) mentioned that the use of mud-blobs on either side of the initial ring may stabilise the swinging nest in high winds. But an additional or alternative function is also possible. About the quantity of mud or dung used in a nest, Ali's figures are somewhat less compared to some of those wet weights given in Table 2. Most of his earlier observations relate to nests from Maharashtra State where birds fix smaller quantities of mud whenever they use it. The quantity of mud used in one of the nests taken from a mahua tree (*Madhuca longifolia*) standing in a flooded rice field near Varanasi (U.P.) should have been more than what Jerdon had mentioned. While admitting that any extra weight in the nest will contribute towards its stability, and reduce the tilt during wind, it is rather unconvincing that small quantities of mud, and in many cases cattle dung that becomes so light when dry (one seventh), can prevent the nest from such violent swayings the nest is subjected to during gales. Moreover, mud is usually smeared only on two fixed positions. If balancing disproportionate nests, arising out of faulty construction, is the main purpose of the mud, why is it that it is always placed at specific regions? Small changes in the alignment of the nest can be brought about by making minor modifications in the construction of the nest. Another reason why the balancing theory seems untenable is the fact that the ball nests of *Ploceus megarhynchus* which are placed on branches and not liable to be tossed about by wind also have mud-plastering on the inner wall (Ali & Crook 1959). Moreover, even in some nests hung on outgrowths on the walls of wells which are adequately protected from wind have mud-blobs.

An ancient custom

Ali (1931) suggested that the habit of sticking mud in the nests is a form of atavism—the relic of some ancient custom at one time beneficial to the species. He also hoped that a study of allied forms, their evolution and development might throw some light on this point. Wood (1926) was also of similar opinion. Most of the 95 species of weavers (Ploceinae) occur in Africa and only five are known in Asia (*Ploceus philippinus*, *P. manyar*, *P. benghalensis*, *P. megarhynchus* and *P. hypoxanthus*). According to Crook (1963), the ancestors of the Asian weavers invaded Asia from Africa at a time or times, when a suitable tract of country connected the two continents. None of the Asian species has any particular relationship with any existing African *Ploceus* species. Although at least four of the Asian weavers are reported using mud-plastering inside the nest, none of the African species is known to use clay or dung in its nest. Hence, the probability of this habit being an ancestral trait is not high. Incidentally, the limited number of nests of *P. benghalensis* that I had dissected (2 from Varanasi, 2 from Karnal and 3 from Calcutta) did not show any mud or dung, one of them shown in Plate II, Fig. 4 is from Varanasi.

Protection against rain

Crook (1963) gave yet another explanation for the mud-blobs : that they give shelter to the inmates from pouring rain. He mentioned that *Ploceus manyar* and *P. benghalensis*, like *P. philippinus*, plaster part of the egg-chamber wall with mud which, when dry, is probably a most effective barrier to water. But the baya nest is adequately built not only to withstand the severe gale that accompanies the South-West Monsoon, but also to protect the inmates from being drenched. As the fibre nest is sufficiently thick at least at the roof, no water can enter and stagnate in the egg-chamber. Moreover, within minutes of the rain stopping, the nest gets dry as the porous nest allows quick evaporation. On the other hand, if the nest is not otherwise proof against rain, during heavy rains, mud plastering can soak down and cause more discomfort and health hazards to the young. Here, cattle dung coating can be effective rather than mud-plastering. Another objection to this proposition is that nests built in regions having high precipitation do not have large quantities of mud plastering. Parts of west coast of India receive over 2500 mm of rainfall every year. In the Tamil Nadu, Kerala and Mysore regions of West Coast, coconut is the most preferred tree siting for baya nests. This palm also provides very strong leaf fibre for nest-building. In these nests, either no mud is fixed at all or very negligible quantities are seen. In the north-eastern region of India comprising West Bengal, Bihar and Orissa where the rainfall is only about 1000 mm per annum, baya nests show the maximum amount of the plaster. Moreover, the use of dung, a relatively better rainproof material is prevalent here. The rain-proofing theory may further run into difficulties atleast with baya nest, since the portion of the nest that faces the source of rain or wind is the egg-chamber. The central strip of the egg-chamber that faces rain most is devoid of any plaster since the mud patch or patches are seen on either side away from the middle line (Text-fig. 2).



TEXT-FIG. 2. Male baya perching on the lower portion of ring and fixing a mud blob at a point not far from the ring.

The hemispherical shape of the egg-chamber results from the fact that the male baya invariably builds while perching on the bottom of the ring. Hence, weaving is extended up to where his beak can reach. The bird obviously struggles to weave along the middle strip of the egg-chamber, the farthest region from the ring. This is also the region which is least accessible to the female at the time of her critical nest-examination. As explained earlier, the male carrying a heavy load finds it difficult to reach the middle strip of the egg-chamber. Therefore, he fixes the mud on the side wall nearer to the ring (Text-fig. 2). Thus, two regions are equally close to him, and accordingly, he fixes the mud or dung in two patches. The bird shows no preference for any particular direction for smearing the mud since there are some nests where only one patch is seen either on the left or right side. Some nests have an excess quantity of the plaster on one side either on the left or right. The numerous nests not having any mud/dung do not support the rainproofing theory.

Plastering reinforces nest

The above discussion shows that the various explanations offered by different ornithologists on the presence of mud/dung in the baya nest are not fully convincing. My views agree with those of Burgess (quoted by Jerdon) who mentioned that the plastering serves to strengthen the nest. Crook also conceded to this view indirectly. The following information may support this point :

1. Dismantling a nest, fibre by fibre, is impossible without removing the mud/dung coating wherever it is present. In order to find out the total number of fibres involved in the weaving of different types of baya nests from different regions of India, a few nests were dissembled. Separating the fibre from the free end of the entrance tube backwards, obviously, is the easiest possible way to dismantle a nest. The first nest chosen was a medium-sized coconut fibre nest removed from a coconut palm from Kerala. There were only 4 or 5 loads of mud fixed in two small patches. Dismantling the nest beyond three-fourths the tube was almost impossible since most of the long fibres were caught by the mud directly, or firmly entangled with those fixed by the mud. Removing the dry mud meant breaking of some fibre. Hence the nest was soaked in warm water and the mud washed away. This explains the powerful cementing capacity of even limited number of mud-blobs. Incidentally, the process of separating the fibres of this particular nest took a little over 14 hours, spread over 4 days. This nest had a total of 4,002 fibres (allowing a 2-3% increase due to the breakage of fibre) which measured a total length of about 800 metres. Since coconut leaflets yield very long (one fibre measured even 85 cm) and strong

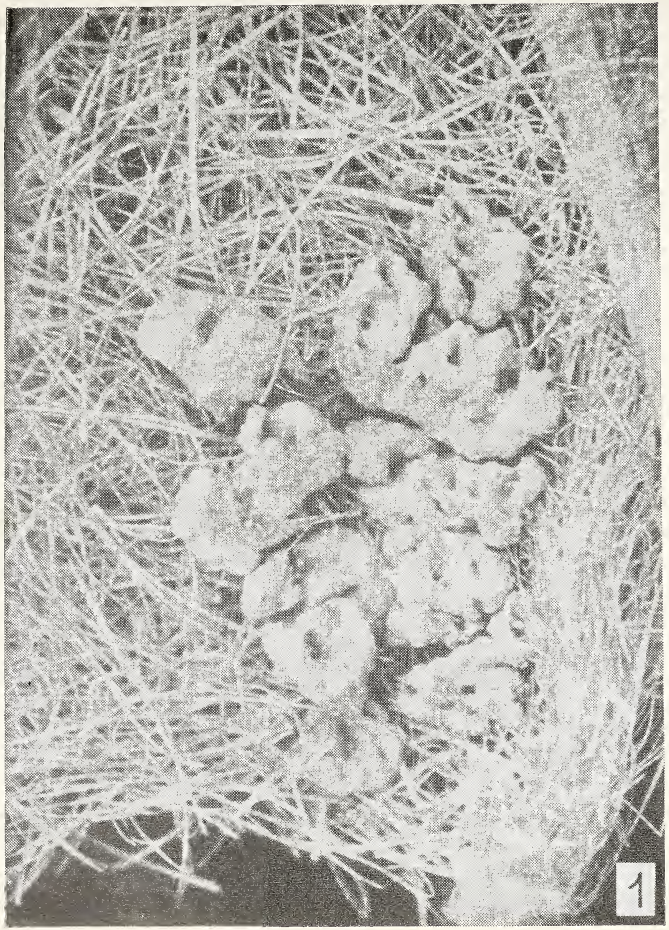
fibre, the number used in this nest is much less compared to that of a nest made of grass blades.

2. Crook (1964) who conducted several tests on the baya, made the following remarks on the use of mud-blobs. 'In tests on nests under construction in which the ring was removed, mud-blobs were found scattered at random on the exterior of the structure and even near the point of attachment to the support.' Although this illustrates the importance of building position in determining the organisation of the normal structure, this also clearly demonstrates the importance of mud as a binding material. The ring being the vital framework of the nest, restoration of damage requires the maximum effort. Since the ring is formed directly from the initial wad at the attachment of the nest with an organ of the host tree, the bird's attempts to fortify even the point of attachment only suggest baya's response to reorient the ring from the initial point of the foundation.

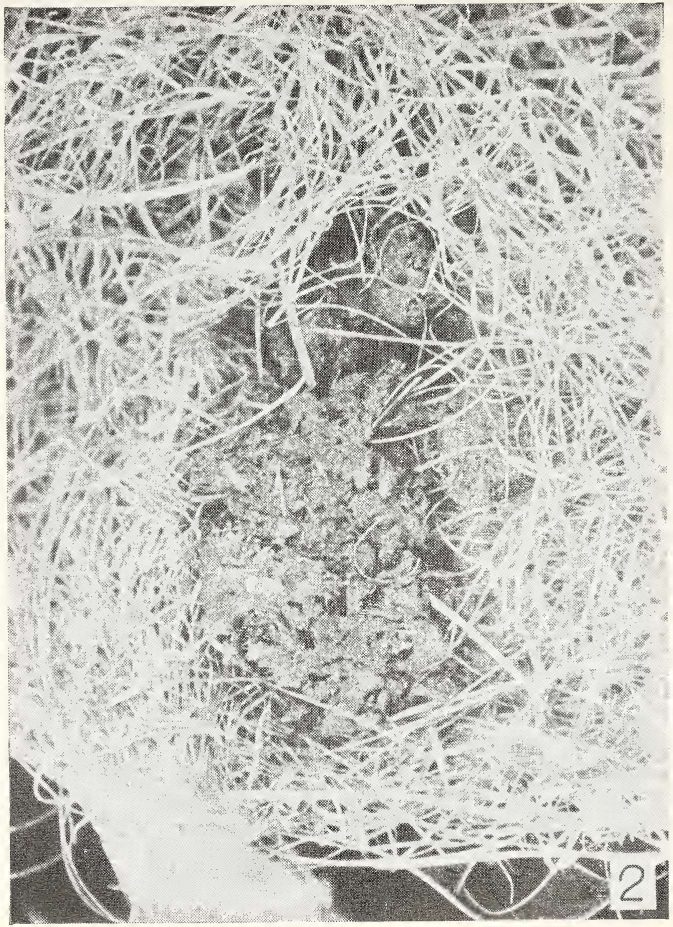
3. The plaster keeps the nest intact in spite of the female's rather violent examination. When a female in search of a nest and a mate enters a half-built nest, she invariably perches on the ring and starts examining it by poking her beak into the walls of the egg-chamber and also by pulling out fibre. The two regions that are easily accessible to her are smeared with mud/dung which reduce her critical examination and save some more fibre from getting pulled out. On the other hand, the plaster appears to reassure her of the strength of the nest, and owners of such nests are likely to get mates quickly. During some of her visits, the nest examiner spends even up to ten minutes at a time in a nest. During this period, she is occasionally seen picking up small pieces of the plastering material and working them between the beaks. The exact significance of this is not clear. Whether there is any need to sharpen the beak, and how far the mud/dung helps this, remains to be investigated.

4. Nests built of long and strong fibre as those from leaves of coconut, sugarcane and some wild sugarcane have relatively small quantities of mud or none at all, while those built with weak fibre like those of rice, maize and banana leaves have heavy plastering. Nests in high rainfall areas generally have smaller quantities of mud in them.

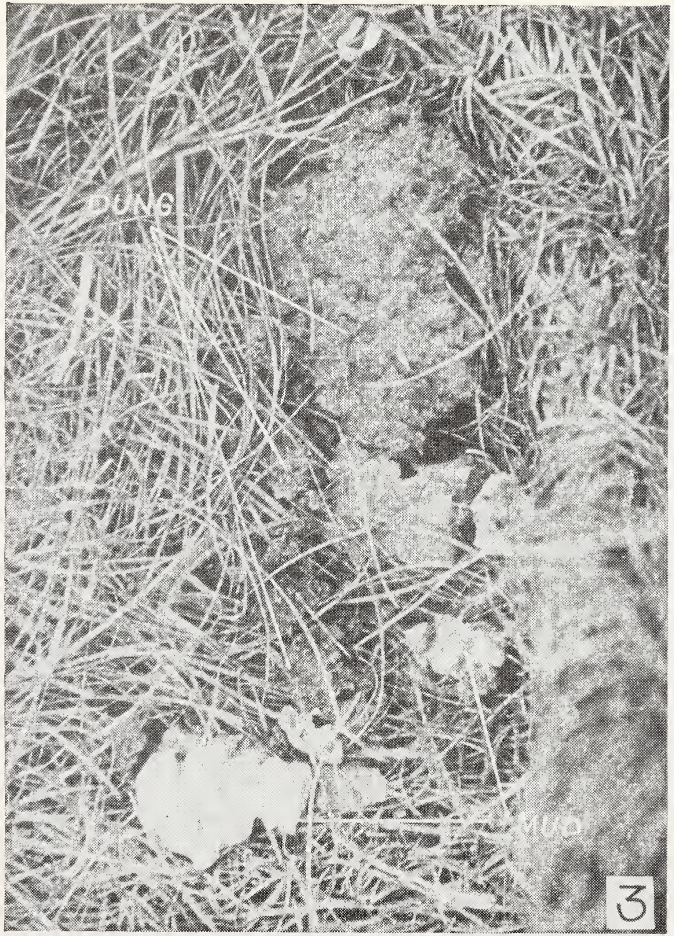
5. The quantity of the plaster varies with the quality of nest-weave. For example, in many regions, the baya uses rice leaves. Those in north-eastern India use the whole unsplit blade or as very broad strips, and eventually such nests are not firm and compact and so they require more cementing material. But the birds in parts of Andhra, Maharashtra and Karnataka States, strip a rice blade into several narrow strands and weave the nest more carefully. Such nests generally do not possess any mud/dung.



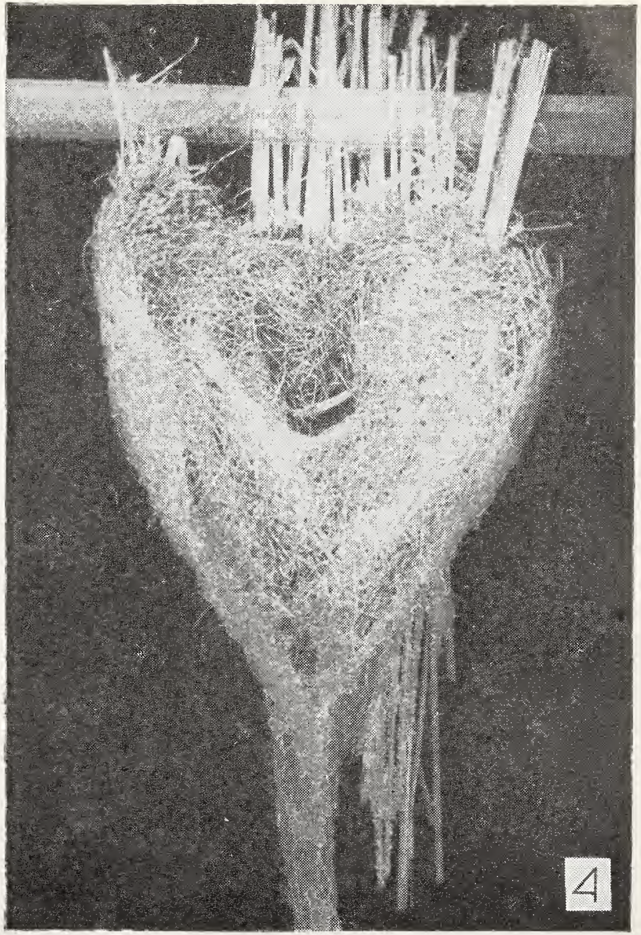
1. A patch of mud-blobs showing persisting beakmarks.



2. A portion of a heavy dung plastering covered by fibre.



3. Mud-blobs and dung plaster used in the same patch.



4. Inner view of *Ploceus benghalensis* nest.

6. A majority of the rejected nests as well as those woven by young males do not have any mud/dung coating at all.

7. The female is not known to weave a nest although she seems capable of selecting a durable one. The success of a brood depends on the strength of the nest since if the nest gives way when it holds either eggs or young, it can only end in disaster, since the female is apparently incapable of nest-repair. Such a selection of an efficient nest becomes all the more meaningful since the male generally deserts his mate and nest when the hen starts brooding her eggs. Ambedkar (1964) reported that some males not only look after the nest subsequently, but also feed the young though not as frequently as the females. The binding effect of the mud/dung need not be over-emphasized. The region of the nest likely to be strained most is the egg-chamber on account of the weight of the young and that of the mother, as well as the strain caused by the hen's frequent flights in and out of the nest. Therefore, additional reinforcement of the vulnerable part of the nest has been effected by the cementing material that is usually seen in large quantities inside nests which are otherwise weak.

ACKNOWLEDGEMENT

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Contribution to the Flora of Tirap Frontier Division

BY

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[*Continued from Vol.* **69** (3) : 573]

ANACARDIACEAE

Rhus semialata Murr.

Small tree with dull white flowers ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19934. Namsang-Shoha, Oct. 1959, *Rao* 20345.

R. succedanea Linn. var. **acuminata** (DC.) Hook. f.

Medium-sized tree in fruit. One of the most common trees of this forest. Banfera-Kanubari, July 1961, *Deb* 26746.

Pegia nitida Colebr.

Tapiria hirsuta Hook. f.

A scandent shrub. Chenglang, March 1958, *Murthy* 12913.

ACERACEAE

Acer laevigatum Wall.

Large tree in fruit ; scarce. Chennhang, June 1961, *Deb* 26279.

STAPHYLEACEAE

Turpinia nepalensis Wall. ex Wt. et Arn.

Small tree in fruit ; fruits 3-seeded, globose ; common. Chennhang, June 1961, *Deb* 26245, 26246, & 26249 ; Lailongsong, 510 m, June 1961, *Deb* 25804.

POTALIACEAE

Fagraea obovata Wall. ex Roxb.

Medium-sized tree with yellow flowers ; common. Chennhang, June 1961, *Deb* 26237.

BUDDLEIACEAE

Buddleia asiatica Lour.

Shrub with small, pinkish showy flowers ; scarce. Chennhang, March 1958, *Murthy* 12926.

B. macrostachya Benth.

Shrub in fruit. Fruits dark brown on drying ; common. Lailongsong, June 1961, *Deb* 26131 ; Noglo, June 1961, *Deb* 26352.

STRYCHNACEAE

Gardneria ovata Wall.

Shrub in flower, rare. Pungchow, July 1961, *Deb* 26619.

Strychnos wallichiana Benth.

Climber with large fruits ; rare. Kanubari, July 1961, *Deb* 26757.

OLEACEAE

Jasminum amplexicaule G. Don

Climber with white flowers. Margharita-Jairampur, Oct. 1959, *Rao* 19965.

J. attenuatum Roxb.

A climber in flower ; scarce. Wakka, July 1961, *Deb* 26523.

J. coarctatum Roxb.

Shrub with white mild scented flower, scarce. Pungchow, July 1961, *Deb* 26595 ; Chenglang-Khela, March 1958, *Murthy* 12940.

J. glandulosum Wall. ex DC.

A scandent climber with white flowers ; rare. Pungchow, July 1961, *Deb* 26618 ; Wakka-Nagminu, July 1961, *Deb* 26536.

J. sambac Ait.

A wild Jasmine with white flowers, fairly common. Namchick, 152 m, Oct. 1959, *Rao* 20176.

J. subtriplinerve Bl.

Shrub ; scarce. Pungchow, July 1961, *Deb* 26631.

Ligustrum robustum Bl.

A tall shrub in fruit ; scarce. Chennhang, June 1961, *Deb* 26209 ; Langsang forest, June 1961, *Deb* 26127.

L. roxburghii Clarke

Small tree with white flowers; scarce. Laju-Raho, Aug. 1958, *Panigrahi* 14713 ; Jadua-Banfera, July 1961, *Deb* 26687.

Myxopyrum smilacifolium Bl.

A twiner on shrubs ; in fruit ; scarce. Deomali, Oct. 1959, *Rao* 20323.

APOCYNACEAE

Chonemorpha fragrans (Moon) Alston

A large climber with scented white flowers ; rare. Chenglang-Khela, 600 m, March 1958, *Murthy* 12941 ; Tipang, June 1961, *Deb* 25716 ; Banfera, June 1961, *Deb* 26708.

C. griffithii Hook. f.

A stout climber with scented white flowers. Langsang forest, June 1961, *Deb* 26144.

Ichnocarpus ovatifolius A. DC.

Climber with white flowers; scarce. Banfera-Kanubari, July 1961, *Deb* 26731.

Melodinus khasiana Hook. f.

A tall climber with milky juice. Flowers white ; scarce. Langsang forest, June 1961, *Deb* 26120 ; Pungchow, July 1961, *Deb* 26629.

M. monogynus Roxb.

Climber with white flowers. This is larger than *M. khasiana* Hook f.; rare. Noglo, June 1961, *Deb* 26363.

Pottsia laxiflora (Bl.) O. Kuntze

A scandent shrub with purple flowers ; scarce. Tipang, June 1961. *Deb* 25706.

Strophanthus wallichii A. DC.

Shrub with scented white flowers. Jangkeng village, June 1961. *Deb* 25865.

Tabernaemontana divaricata (Linn.) R. Br. ex Roem. et Schult.

A small shrub with white flowers ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19919 ; Namchick, 152 m, Oct. 1959, *Rao* 20185 ; Chenglang, Oct. 1959, *Rao* 20246.

Trachelospermum axillare Hook. f.

A climber with milky juice. Scented red or pink flowers ; rare. Chegum-Wakka, July 1961, *Deb* 26470 ; Chennhang, June 1961, *Deb* 26208 ; Pungchow, July 1961, *Deb* 26607.

T. lucidum (D. Don) K. Sch.

Shrub with white flowers. Noglo, June 1961, *Deb* 26353.

PEREPLOCACEAE

Cryptolepis buchanani Roem. & Schult. f.

Climber with fruits ; scarce. Pungchow, July 1961, *Deb* 26588.

C. sinensis (Lour.) Merr.

C. elegans Wall. ex G. Don

Climber with pale yellow flowers; scarce. Lunwa, July 1961, *Deb* 26640 ; Lailongsong, 510 m, June 1961, *Deb* 25801.

Pentanura khasiana Kurz

Climber with milky juice in pinkish white flowers ; scarce. Jadua-Banfera, July 1961, *Deb* 26694 ; Pungchow, July 1961, *Deb* 26603.

Periploca calophylla Falc.

A much-branched climber in fruits. Chennhang, June 1961, *Deb* 26219 ; Wakka, July 1961, *Deb* 26510.

ASCLEPIADACEAE

Asclepias curassavica Linn.

An undershrub. Flowers bright red with yellow projecting corona ; scarce. Chenglang, Oct. 1959, *Rao* 20247.

Ceropegia angustifolia Wight

Climber with yellowish brown flowers with brown stripes ; rare. Laju-Raho, Aug. 1958, *Panigrahi* 14748.

Cynanchum wallichii Wt.

A climber. Pungchow, July 1961, *Deb* 26573.

Dischidia bengalensis Colebr.

An epiphyte with milky juice on *Schima wallichii* Choisy ; common, Jadua, July 1961, *Deb* 26662,

D. nummularia R. Br.

A small epiphyte with linear fruits; rare. Khela, March 1958, *Murthy* 12970.

Dregea volubilis (Linn. f.) Benth. ex Hook. f.

A scarce twiner. Soha village, 1067 m, Oct. 1959, *Rao* 20363.

Haterostemma alatum Wt.

Twiner with brownish-yellow flowers; scarce. Chegum-Wakka, July 1961, *Deb* 26491.

Hoya lanceolata Wall. ex D. Don.

An epiphyte with creamy-white flowers with pinkish stamens; common. Wakka, Aug. 1958, *Panigrahi* 14935; Raho, July 1961, *Deb* 26457; Deomali, June 1961, *Deb* 25909.

H. linearis Wall. ex D. Don.

An epiphyte with milky latex; scarce. Chennhang, June 1961, *Deb* 26183.

H. longifolia Wall. ex Wt.

An epiphyte with white flowers; scarce. Kothong, June 1961, *Deb* 26044; Chegum-Wakka, July 1961, *Deb* 26475; Khonsa-Laju, June 1961, *Deb* 25990.

H. parasitica Wall.

A climber on *Shorea robusta* Linn. f. with white flowers; common. Deomali, June 1961, *Deb* 25881.

Tylophora belostemma Benth.

A climber. Chegum-Wakka, July 1961, *Deb* 26480.

T. hirsuta (Wall.) Wt.

Climber with small violet flowers; rare. Pungchow, July 1961, *Deb* 26579.

RUBIACEAE

Acranthera tomentosa Br.

A scarce shrub. Banfera, July 1961, *Deb* 26709.

Coffea arabica Linn.

A bushy shrub with white flowers. Cultivated. Khela, June 1961, *Deb* 25933.

Galium asperifolium Wall. ex Roxb.

A diffused herb with very small flowers ; common. Khonsa, June 1961, *Deb* 25971 ; Chennhang, June 1961, *Deb* 26218 ; Kothong, June 1961, *Deb* 26073.

Hedyotis verticillata (L.) Lamk.

Herb with small white flowers ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19925 ; Niausa, July 1961, *Deb* 26564.

H. lindleyana Hook. f. ex Wt. & Arn.

A prostrate herb with white flowers, scarce. Raho, July 1961, *Deb* 26427.

H. scandens Roxb. ex D. Don

An undershrub with ripe bluish fruits, common. Margharita-Jairampur, Oct. 1959, *Rao* 19943 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20055 ; Niausa. Sept. 1958, *Panigrahi* 15011, Langsang forest, June 1961, *Deb* 26140,

H. vestita R. Br. ex G. Don

Herb with greenish violet flowers ; rare. Pungchow, July 1961, *Deb* 26587.

H. diffusa Willd.

A common herb. Soha village, Oct. 1959, *Rao* 20372.

Knoxia sumatrensis (Retz.) DC.

A rare herb. Jadua-Banfera, July 1961, *Deb* 26686.

Lasianthus biermanni King ex Hook. f.

Shrub with globose, winged fruits ; common. Chennhang, June 1961, *Deb* 26248 ; Chegum-Wakka, July 1961, *Deb* 26481.

L. sikkimensis Hook. f.

Shrub in fruit ; scarce. Pungchow, July 1961, *Deb* 26593.

L. tubiferus Hook. f.

A common shrub. Chegum-Wakka, July 1961, *Deb* 26478.

Morinda angustifolia Roxb.

Shrub with white flowers ; scarce. Jadua-Banfera, July 1961, *Deb* 26673 & 26674 ; Deomali, June 1961, *Deb* 25883 ; Banfera, July 1961, *Deb* 26701.

M. villosa Hook. f.

A shrub about 3 m in height with orange red fruits ; rare. Rusa-Bimalpur, Sept. 1958, *Panigrahi* 16913.

Mussaenda glabra Vahl

Shrub with hirsute flowers and dark green fruits; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20030; Jangkeng village, June 1961, *Deb* 25866; Raho, July 1961, *Deb* 26416; Chennhang, June 1961, *Deb* 26212; Chenglang, March 1958, *Murthy* 12914.

M. glabrata (Hook. f.) Hutch.

Shrub with green globular fruits; scarce. Jairampur, Oct. 1959, *Rao* 19973; Nampong-Pangsupass, Oct. 1959, *Rao* 20018.

M. macrophylla Wall.

Shrub with globose, hairy fruits; scarce. Kothong, June 1961, *Deb* 26021 & 26077; Lailongsong, 510 m, June 1961, *Deb* 25811.

M. roxburghii Hook. f.

Shrub with modified sepals white, leaf-like; in fruit; common. Tipang, 540 m, June 1961, *Deb* 25702; Longsek hillock, 1500 m, June 1961, *Deb* 25732.

M. wallichii G. Don

An undershrub with yellow flowers; common. Tipang, 540 m. June 1961, *Deb* 25700.

Mycetia longifolia (Wall.) O. Kuntze

Shrub with small, creamy white or yellow flowers; scarce. Nampong- Pangsupass, Oct. 1959, *Rao* 20069; Wakka, July 1961, *Deb* 26508; Jangkeng village, June 1961, *Deb* 25859; Banfera, July 1961, *Deb* 26707.

Myrioneuron nutans Wall. ex Kurz

An undershrub with small yellow fruits; scarce. Niausa, Sept 1958, *Panigrahi* 16714; Banfera, July 1961, *Deb* 26704; Pungchow, July 1961, *Deb* 26576.

Neanotis ingrata (Wall. ex Hook. f.) W. H. Lewis

A soft herb with white flowers; common. Rusa, Sept. 1958, *Panigrahi* 16946; Chenglang-Khela, Oct. 1959, *Rao* 20265.

N. wightiana (Wall. ex Wt. et Arn.) W. H. Lewis

Small herb with white or violet flowers, scarce. Chennhang, June 1961, *Deb* 26184 & 26203; Langsang forest, June 1961, *Deb* 26136.

Ophiorrhiza calcarata Hook. f.

Herb with pink flowers; rare. Jangkeng village, June 1961, *Deb* 25864.

O. harrisiana Heyne

A common herb with white flowers. Grows gregariously and forms the undergrowth in moist situations. Pungchow, July 1961, *Deb* 26612; Noglo, June 1961, *Deb* 26333.

O. pauciflora Hook. f.

Small herb with white flowers; fairly common. Pungchow, July 1961, *Deb* 26601.

O. succirubra King ex Hook. f.

Herb with pink flowers; common. Chennhang, June 1961, *Deb* 26262; Langsang forest, June 1961, *Deb* 26121 & 26122.

O. treutleri Hook. f.

A succulent herb with pink flowers and green fruits; scarce. Kothong, June 1961, *Deb* 26065.

Paederia scandens (Lour.) Merr.

A twiner with hairy, violet flowers with pungent odour; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20014.

Pavetta subcapitata Hook. f.

Shrub with globose berries; scarce. Banfera, July 1961, *Deb* 26700.

Polyura geminata Hook. f.

A small herb with very minute red or pink flowers; common. Deomali, Oct. 1959, *Rao* 20392; Jadua, July 1961, *Deb* 26670; Deomali, June 1961, *Deb* 25888; Longsek hillock, 1500 m, June 1961, *Deb* 25737.

Psychotria fulva Buch.-Ham.

Herb with small flowers and fruits; scarce. Banfera, July 1961, *Deb* 26699; Lailongsong, 510 m, June 1961, *Deb* 25826; Longsek hillock, 1500 m, June 1961, *Deb* 25731.

P. montana Bl.

A common shrub. Fruiting; Langsang forest, June 1961, *Deb* 26128.

P. thomsonii Hook. f.

A common shrub of the undergrowth. Chegum-Wakka, July 1961, *Deb* 26469.

Randia griffithii Hook. f.

A tree in fruit. Khonsa-Laju, June 1961, *Deb* 25960.

R. wallichii Hook. f.

A medium-sized tree in flower, scarce. Chennhang, June 1961, *Deb* 26250.

Rubia sikkimensis Kurz

A rare climber. Langsang forest, June 1961, *Deb* 26154.

Saprosma ternatum Hook. f.

A shrub about 3 m in height. Fruiting; rare. Nginu-Niausa, Aug. 1958, *Panigrahi* 14802.

Spermacoce ocymoides Burm. f.

A common herb with woody base, white flowers and fruits. Lailongsong, 510 m, June 1961, *Deb* 25824.

Spiradiclis bifida Wall. ex Kurz

A common succulent herb with very small, pale white flowers; common. Tipang, June 1961, *Deb* 25705, Lailongsong, 510 m, June 1961, *Deb* 25822.

S. cylindrica Wall. ex Hook. f.

Small herb with small yellow or creamy-white flower; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20279; Lailongsong, 510 m., June 1961, *Deb* 25823; Chennhang, June 1961, *Deb* 26185.

Tarenna odorata (Roxb.) Robinson

Tree with white flowers and fruits; rare. Deomali, June 1961, *Deb* 25879.

Uncaria macrophylla Wall.

A large shrub, scandent, in fruit. Margharita- Jairampur, Oct. 1959, *Rao* 19952.

U. homomalla Miq.

A scandent shrub with fruits; scarce. Chenglang, March 1958, *Murthy* 12915.

U. sessilifructus Roxb.

A large scandent shrub in fruit; scarce. Namchick-Chenglang, Oct. 1959, *Rao* 20211 (A); Raho-Wakka, July 1961, *Deb* 26393.

Meyna laxiflora Robyns

Vangueria spinosa Roxb.

A bushy shrub with flowers and fruits growing in clearings in the forest. Lunwa, July 1961, *Deb* 26641.

Wendlandia wallichii Wt. & Arn.

A small tree with small, sessile flowers and greyish green fruits in large bunches; common. Chennhang, June 1961, *Deb* 26244; Wakka, July 1961, *Deb* 26505.

BIGNONIACEAE

Radermachera bipinnata (Coll. et Hemsl.) Van Steenis

A climber. Flower showy, yellow outside and violet inside. This is worthy of introduction as an ornamental plant. Langsang forest, June 1961, *Deb* 26124 ; Khonsa-Laju, June 1961, *Deb* 25943.

R. gigantea Miq.

A rare tree. Fruiting. Pungchow-Niausa, June 1961, *Deb* 26645.

Stereospermum personatum (Hassk.) Chatter.

A medium-sized tree with violet and yellowish tinged flower ; common, Longsek hillock, June 1961, *Deb* 25720 ; Wakka, July 1961, *Deb* 26537. Banfera-Kanubari, July 1961, *Deb* 26743.

PEDALIACEAE

Sesamum indicum Linn.

Cultivated near cottages. Margharita-Jairampur, Oct. 1959, *Rao* 19946.

VERBENACEAE

Callicarpa arborea Roxb. ex C. B. Clarke

A small tree with violet or pinkish flowers ; scarce. Banfera, July 1961, *Deb* 26697 ; Lailongsong, 510 m., June 1961, *Deb* 25788.

C. longifolia Lamk. var. **lanceolaria** Clarke

A shrub in the exposed region of the forest ; scarce. Deomali, Oct. 1959, *Rao* 20320 ; Deomali, July 1961, *Deb* 25892.

C. rubella Lindl.

A shrub with purple flowers and fruits ; common. Khonsa, June 1961, *Deb* 25916 ; Kothong, June 1961, *Deb* 26074.

Clerodendron bracteatum Wall. ex Walp.

A shrub with ripe bluish fruits ; Banfera-Kanubari, July 1961, *Deb* 26740.

C. colebrookianum Walp.

A shrub with white flower and dark green fruits with calyx ; common. Margharita-Jairampur, Oct. 1959, *Rao* 19956 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20041 ; Deomali, Oct. 1959, *Rao* 20388.

C. divaricatum Jack

A tall shrub with whitish blue flowers and oily green fruits ; common. Lailongsong (Chenglang), 510 m, June 1961, *Deb* 25816 ; Deomali, Oct. 1959, *Rao* 20393 ; Pungchow, July 1961, *Deb* 26585.

C. hastatum Lindl.

A small tree ; scarce. Banfera-Kanubari, July 1961, *Deb* 26737.

C. lasiocephalum C. B. Clarke

Shrub with dull to deep red flowers and small green fruits ; scarce. Chenlang-Khela, Oct. 1959, *Rao* 20268 ; Kothong, June 1961, *Deb* 26085 ; Chenglang-Khela, March 1958, *Murthy* 12954.

Premna racemosa Wall. ex Schaner.

Shrub or small tree with white, small flowers ; scarce. Raho-Wakka, July 1961, *Deb* 26442 ; Pungchow, July 1961, *Deb* 26608 & 26630 ; Pungchow-Niausa, July 1961, *Deb* 26651 ; Noglo, June 1961, *Deb* 26328 & 26364.

Verbena officinalis Linn.

An undershrub ; very common. Khonsa-Laju, June 1961, *Deb* 25998 ; Kothong, June 1961, *Deb* 26072.

Vitex canescens Kurz

A big tree in zygomorphic, dull white flowers with externally tomentose corolla ; scarce. Chennhang, June 1961, *Deb* 26207.

V. heterophylla Roxb.

A medium-sized tree with small white flowers and fruits ; common. Chenglang-Khela, Oct. 1959, *Rao* 20258 ; Longsek hillock, 1500 m, June 1961, *Deb* 25728.

V. negundo Linn.

A shrub with blue-violet flowers ; common. Niausa, July 1961, *Deb* 26556.

HELLEBORACEAE

Isopyrum adiantifolium Hook. f. & Th.

A succulent herb. This is recorded to occur in Sikkim and upper Burma only (*vide* S. K. Mukerjee in *Bull. Bot. Surv. India* **2** : 106, 1960). This record from NEFA indicates that it is distributed all over the Eastern Himalayas from Sikkim to Burma. Raho-Wakka, July 1961, *Deb* 26435.

RANUNCULACEAE

Anemone howellii W. W. Smith & Jeff.

A herb with dull white flowers ; scarce. Wakka, July 1961, *Deb* 26407.

Ranunculus diffusus DC.

A herb with yellow flowers ; scarce. Raho-Wakka, July 1961, *Deb* 26314.

R. laetus Wall. ex Royle

Herb with yellow flowers ; common. Khonsa-Laju, June 1961, *Deb* 25975.

R. cantoniensis DC.

Herb in yellow flowers ; scarce. Kothong, June 1961, *Deb* 26050 ; Pungchow, July 1961, *Deb* 26596.

Thalictrum foliolosum DC.

A herb with small flowers ; scarce. Wakka, July 1961, *Deb* 26514.

MENISPERMACEAE

Aspidocarya uvifera Hook. f. & Thoms.

A climber with red flowers ; rare. Pungchow, July 1961, *Deb* 26616 & 26628.

Haematocarpus thomsonii Miers

A woody climber ; rare. Langsang forest, June 1961, *Deb* 26147.

Pericamphylus glaucus (Lamk.) Merr.

A climber with small flowers ; scarce, Chennhang, June 1961, *Deb* 26189 ; Langsang forest, June 1961, *Deb* 26148 ; March 1958, *Murthy* 12907.

Stephania japonica (Thunb.) Miers var. **discolor** (Miq.) Forman

A climber with red fruits ; scarce. Jairampur, Oct. 1959, *Rao* 19979 ; Lailongsong, 510 m., June 1961, *Deb* 25786 ; Kothong, June 1961, *Deb* 26114.

ARISTOLOCHIACEAE

Aristolochia platanifolia Duchart.

A climber with 6-ridged fruits ; scarce. Wakka, July 1961, *Deb* 26501.

A. saccata Wall.

Climber with tan coloured flowers ; common. Chennhang, June 1961, *Deb* 26239 ; Raho-Wakka, July 1961, *Deb* 26405 ; Noglo, June 1961, *Deb* 26319.

Asarum himalaicum Hook. f. & Th. var. **bhutanicum** W. W. Smith

A succulent herb. Grows in moist, shaded area ; rare. Raho-Wakka, July 1961, *Deb* 26421.

PIPERACEAE

Peperomia heyneana Miq.

A succulent herb, sometimes grows as an epiphyte ; common. Raho-Vokanoska, Aug. 1958, *Panigrahi* 16845 ; Kothong, June 1961, *Deb* 26090, Khonsa-Laju, June 1961, *Deb* 25970 ; Noglo, June 1961, *Deb* 26354.

P. pellucida (Linn.) H.B.K.

An annual succulent herb ; common. Banfera-Longhoi, Aug 1958, *Panigrahi* 16755.

P. tetraphylla (Forst. f.) Hook. et Arn.

An epiphyte ; scarce. Chennhang, June 1961, *Deb* 26196 ; Khonsa-Laju, June 1961, *Deb* 25970.

Piper attenuatum Buch.-Ham.

A climber ; scarce. Jadua-Banfera, July 1961, *Deb* 26667 ; Lailongsong, 510 m, June 1961, *Deb* 25813.

P. betle Linn.

A cultivated twiner. Soha village, Oct. 1959, *Rao* 20361.

P. boehmeriaefolium Wall. ex C. DC. forma **glabrifolium** DC.

A scarce climber ; fruiting. Kheti-Tinchha, Aug. 1958, *Panigrahi* 14542.

P. mannii DC.

An epiphyte with spikes ; scarce. Raho, Aug. 1958, *Panigrahi* 16823 ; Noglo, June 1961, *Deb* 26336.

P. mullesua D. Don

Succulent epiphyte ; scarce. Langsang forest, June 1961, *Deb* 26116 ; Longsek hillock, 1500 m, June 1961, *Deb* 25748.

P. nepalense Miq.

An epiphyte with about 25 cm long spike ; scarce. Pungchow, July 1961, *Deb* 26597 ; Longsek hillock, 1500 m, June 1961, *Deb* 25755.

P. nigrum Linn. var. **macrostachyum** C. DC.

A succulent shrub with solitary whitish green spike ; rare. Wakka, Aug. 1958, *Panigrahi* 14925 ; Kothong, June 1961, *Deb* 26045 ; Khela, June 1961, *Deb* 25935.

P. peepuloides Roxb.

A root climber with spike ; common. Deomali, Oct. 1959, *Rao* 20316 ; Longsek hillock, 1500 m, June 1961, *Deb* 25749.

P. sylvaticum Roxb.

A climber with long, pale green spike having small conical fruits ; scarce. Soha village, Oct. 1959, *Rao* 20359.

P. thomsonii Hook. f.

A root climber with erect fruiting spike ; scarce. Jairampur, Oct. 1959, *Rao* 19995 ; Deomali, June 1961, *Deb* 25889 ; Jadua-Banfera, July 1961, *Deb* 26676.

SAURURACEAE

Houttuynia cordata Thunb.

A herb ; bracts white ; scarce. Jangkeng village, June 1961, *Deb* 25852.

CHLORANTHACEAE

Chloranthus officinalis Bl.

An undershrub with very small sessile white flowers ; common. Chenglang-Khela, Aug. 1958, *Panigrahi* 14440 ; Jairampur, Oct. 1959, *Rao* 19997 ; Lailongsong, 510 m, June 1961, *Deb* 25791 ; Jadua-Banfera, July 1961, *Deb* 26677.

PAPAVERACEAE

Papaver somniferum Linn.

A herb with solitary white flowers and fruits ; flowers and fruits vary much in size. Probably an escape from cultivation. Kothong, June 1961, *Deb* 26037.

CRUCIFERAE

Brassica juncea Czern. & Coss.

Herb under cultivation; yellow flower. Chennhang, June 1961, *Deb* 26272.

B. rugosa Prain

Herb. Probably an escape from cultivation. Chennhang, June 1961, *Deb* 26176.

Cardamine circaeoides Hook. f. & Th.

Herb. Noglo, June 1961, *Deb* 26318.

C. hirsuta Linn. var. **sylvatica** Link

An annual herb with small, white flowers ; scarce. Raho, July 1961, *Deb* 26382 ; Noglo-Laju, June 1961, *Deb* 26368.

C. seoriarum W. W. Smith

A herb of moist shady situations at altitudes of 1800-2100 m ; flowers and fruits in May-July. A native of China recorded for India by Deb in *Ind. For.* **91**(3) : 193, 1965. Wakka, July 1961, *Deb* 26411.

MOLLUGINACEAE

Mollugo pentaphylla Linn.

A diffused herb with greenish flowers ; scarce. Niausa, July 1961, *Deb* 26561.

CARYOPHYLLACEAE

Drymaria diandra Bl.

A diffused or prostrate herb with light green or whitish flowers ; common. Nampong-Pangsupass, 791-1128 m, Oct. 1959, *Rao* 20087.

POLYGONACEAE

Fagopyrum cymosum Meissn.

Herb with flowers in white heads. Forms pure stands on the forest floor ; very common. Kothong, June 1961, *Deb* 26050 ; Khonsa-Laju, June 1961, *Deb* 26000.

Polygonum alatum Buch.-Ham.

A herb with white, yellow or pink heads ; common. Khonsa, June 1961, *Deb* 25917 ; Kothong, June 1961, *Deb* 26025 & 26068 ; Chennhang, June 1961, *Deb* 26178 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20149 ; Pungchow, July 1961, *Deb* 26602.

P. barbatum Linn.

A perennial herb with greenish white flowers. Common in marshy places. Rusa-Bimalpur, Sept. 1958, *Panigrahi* 16960.

P. caespitosum Bl.

Herb with white or small pinkish flowers. Common in marshy places. Lailongsong, 510 m, June 1961, *Deb* 25830 ; Nampong-Pangsupass, Oct. 1959, *Rao* 20054.

P. chinense Linn.

A tall herb with white flowers in marshy regions. Lailongsong, 510 m, June 1961, *Deb* 25818 ; Noglo, June 1961, *Deb* 26323 ; Chennhang, June 1961, *Deb* 26257.

P. chinense Linn. var. **malaicum** (Danser) Steward

A perennial herb with brownish red flowers ; rare. Laju hills, Aug. 1958, *Panigrahi* 14662.

P. chinense Linn. var. **ovalifolia** Meissn.

A herb with black fruits. Tipang, 540 m, June 1961, *Deb* 25719.

P. hydropiper Linn. var. **hispidum** (Hook. f.) Steward

A perennial herb with red flowers ; scarce. Khonsa-Kheti, Aug. 1958, *Panigrahi* 14520.

P. hydropiper Linn. var. **flaccidum** (Meissn.) Steward

A perennial herb in greenish white flowers ; scarce. Jairampur, Oct. 1959, *Rao* 20003 ; Chenglang-Khela, Aug. 1958, *Panigrahi* 14435 ; Khonsa-Laju, June 1961, *Deb* 25980.

P. runcinatum Buch.-Ham.

A herb in white flowers ; scarce. Kothong, June 1961, *Deb* 26057.

P. virginianum Linn.

A perennial herb in red flower buds ; scarce. Wakka, Aug. 1958, *Panigrahi* 14911.

Rumex maritimus Linn.

A scarce herb that occurs in small communities. Khonsa-Laju, June 1961, *Deb* 25997.

AMARANTHACEAE

Achyranthes aspera Linn.

A small herb. Longsek hillock, 1500 m, June 1961, *Deb* 25746.

A. bidentata Bl.

A herb with green spike with pinkish tips ; scarce. Pungchow, July 1961, *Deb* 26613 ; Raho-Wakka, July 1961, *Deb* 26418.

Alternanthera paronychioides St. Hill.

An introduced herb with whitish chaffy inflorescence. Wakka, Aug. 1958, *Panigrahi* 14908.

A. sessilis (Linn.) DC.

A soft herb with condensed spike with creamy white flowers ; scarce. Jairampur, Oct. 1959, *Rao* 19985.

A. lividus Linn.

Prostrate herb. Langsang forest (Kothong), June 1961, *Deb* 26141.

Celosia argentea Linn.

A small herb with deep mauve or pinkish spike. Probably an escape from cultivation ; scarce. Chenglang-Khela, 600m, March 1958, *Murthy* 12938.

Cyathula prostrata (Linn.) Bl.

An annual herb with greenish white flowers ; common. Jairampur, Oct. 1959, *Rao* 19993 ; Longsek hillock, June 1961, *Deb* 25746.

LYTHRACEAE

Cuphea balsamona Ch. & Schl.

A prostrate herb with blue flowers ; scarce. Namchick-Chenglang, Oct. 1959, *Rao* 20211.

ONAGRACEAE

Ludwigia octovalvis (Jacq.) Raven sub sp. **sessiliflora** (Mich.) Raven

A scarce herb with yellowish flowers. Margharita-Jairampur, Oct. 1959, *Rao* 19931 ; Deomali, Oct. 1959, *Rao* 20303 & 20304 ; Niausa, July 1961, *Deb* 26562.

Ludwigia prostrata Roxb.

A herb of marshy places ; scarce. Namchick, 152 m, Oct. 1959, *Rao* 20183.

GENTIANACEAE

Canscora andrographioides Griff. ex C. B. Clarke

A common herb, in flower and fruits. Namchick-Chenglang, Oct. 1959, *Rao* 20210.

Exacum tetragonum Roxb.

Herb with beautiful blue flowers ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20161.

Tripterospermum speciosum (Wall.) Raizada

A twiner, in flower ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20033.

PRIMULACEAE

Lysimachia congestiflora Hemsl.

Herb with yellow flowers ; scarce. Chennhang, June 1961, *Deb* 26192. This was originally described from China. Its occurrence is an extension of its distribution.

L. evalvis Wall.

Herb with solitary, pendent flowers ; scarce. Langsang forest, June 1961, *Deb* 26123 ; Chennhang, June 1961, *Deb* 26258.

L. japonica Thunb.

A diffused much branched herb with yellow flowers ; common. Noglo-Laju, June 1961, *Deb* 26371 ; Khonsa-Laju, June 1961, *Deb* 25962, Kothong, June 1961, *Deb* 26059.

L. lobelioides Wall.

Herb with campanulate flowers ; scarce. Kothong, June 1961, *Deb* 26061.

L. laxa Bauda

Herb with yellow flowers ; common. Raho-Wakka, July 1961, *Deb* 26397 ; Noglo, June 1961, *Deb* 26317.

L. rubiginosa Hemsl.

Herb with yellow flowers ; scarce. Chegum-Wakka, July 1961, *Deb* 26483. Originally described from China, this record extends the distribution.

PLANTAGINACEAE

Plantago erosa Wall.

A very common herb in flower. Kothong, June 1961, *Deb* 26095; Lailongsong, June 1961, *Deb* 25815.

UMBELLIFERAE

Eryngium foetidum Linn.

A common perennial herb of open places. Flowering and fruiting. Sometimes cultivated for the leaves and fruits used in curries. Jadua-Banfera, July 1961, *Deb* 26679.

Heracleum wallichii DC.

A rare herb with white flowers, petiole winged with brown streaks. Laju-Raho, Aug. 1958, *Panigrahi* 14787; Chennhang, June 1961, *Deb* 26252.

H. wallichii DC. var. **elator** Clarke

A herb of moist soil; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20267.

Hydrocotyle nepalensis Hook.

A prostrate herb with small flowers. The juice of the leaves mixed with charcoal is used for wounds. The fruit is reputed to be a snake bite cure. Nampong-Pangsupass, Oct. 1959, *Rao* 20026; Tipang, June 1961, *Deb* 25710; Kothong, June 1961, *Deb* 26058; Raho-Wakka, July 1961, *Deb* 26396.

H. podentha Molkenb. var. **podentha** (Molkenboer) C.B. Clarke

A diffused runner; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20271; Langsang forest, June 1961, *Deb* 26142.

Oenanthe thomsonii Clarke

An annual herb with white flowers. Grows gregariously in the ground cover; very common. Khonsa, June 1961, *Deb* 25918; Jangkeng village, June 1961, *Deb* 25860; Kothong, June 1961, *Deb* 26070.

Pternopetalum senii Deb et Dutta

A perennial herb with purple flowers. Raho-Wakka, July 1961, *Deb* 26394.

Sanicula elata Buch.-Ham. ex D. Don

Perennial herb with white flowers and small fruits; rare. Wakka, Aug. 1958, *Panigrahi* 16900; Kothong, June 1961, *Deb* 26056.

LOBELIACEAE

Lobelia affinis Wall. var. **lobbiana** Hook. f. & Thoms.

A herb of moist soil with small, pale bluish violet flowers ; common. Chenglang-Khela, March 1958, *Murthy* 12946.

L. pyramidalis Wall.

Herb with solitary, axillary, bluish flowers ; rare. Chenglang-Khela, Oct. 1959, *Rao* 20261.

L. rosea Wall.

Shrub with violet flowers ; scarce. Khonsa-Laju, June 1961, *Deb* 25993.

L. succulenta Bl.

Small herb with minute violet flowers ; common. Chenglang, March 1958, *Murthy* 12912.

Pratia montana (Reinw.) Hassk.

A soft herb with white flowers ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20025 ; Rusa-Bimalpur, Sept. 1958, *Panigrahi* 16990 ; Raho-Wakka, July 1961, *Deb* 26409.

P. nummularia (Lamk.) A.Br. et Ascherson

A prostrate herb with pinkish flowers and shining chocolate brown fruits. Common in moist places. Chenglang-Khela, Oct. 1959, *Rao* 20257 ; Chenglang-Khela, March 1958, *Murthy* 12945 ; Lailongsong, 510 m, June 1961, *Deb* 25827.

COMPOSITAE

Adenostemma lavenia (Linn.) O. Ktze.

Herb with whitish head ; scarce. Chenglang-Khela, Oct. 1959, *Rao* 20256 ; Wakka-Nagminu, July 1961, *Deb* 26540 ; Raho-Vokanoska, Aug. 1958, *Panigrahi* 16857 ; Pungchow, July 1961, *Deb* 26570.

Ageratum conyzoides Linn.

Herb in violet flowers. Very common in forest clearings. Namchick, Oct. 1959, *Rao* 20174 ; Chennhang, June 1961, *Deb* 26186.

Ainsliaea latifolia (D. Don) Schulz-Bip

A suffrutiscent herb with radical leaves ; scarce. Chennhang, June 1961, *Deb* 26259.

Artemisia nilagirica (C.B. Clarke) Pamp.

A gregarious herb ; very common. Wakka, July 1961, *Deb* 26530.

Bidens biternata (Lour.) Merr. & Sherff.

Herb with pinkish head ; grows gregariously in shade ; scarce. Chenglang, March 1958, *Murthy* 12928 ; Chennhang, June 1961, *Deb* 26188.

B. pilosa Linn.

An annual with white ligulate flowers ; common. Nampong-Pangsupass, Oct. 1959, *Rao* 20053.

Blumea henryi Dunn

Shrub. Khonsa, June 1961, *Deb* 25919.

B. pubigera (L.) Merr.

Shrub. Heads with yellowish stamens ; scarce. Khela-Chenglang, March 1958, *Murthy* 12988.

B. laciniata DC.

Herb with pinkish head ; scarce. Chenglang, March 1958, *Murthy* 12925.

Cnicus griffithii Hook f.

A tall plant. Leaves deeply cleft and thorny. Heads with greenish brown involucre of bracts ; rare. Nampong-Pangsupass, Oct. 1959, *Rao* 20150.

Cosmos caudatus Hook. f.

Herb with yellow flower ; scarce. Khonsa, June 1961, *Deb* 25922.

Crassocephalum crepidiodes (Benth.) S. Moore

A herb with purplish flowers ; common. Chenglang, March 1958, *Murthy* 12921 ; Chennhang, June 1961, *Deb* 26187.

Eclipta prostrata (Linn.) Linn.

Prostrate herb with white flowers ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20024.

Erigeron linifolium Willd.

Herb with whitish disked head ; scarce. Lailongsong 510 m, June 1961, *Deb* 25829 ; Laju-Raho, Aug. 1958, *Panigrahi* 14733.

Eupatorium capillifolium (Lamk.) Small.

A perennial herb. Cultivated as a garden plant. Margharita-Jairampur, Oct. 1959, *Rao* 19904.

Gynura cusimbua (D. Don) Moore

Herb with violet, orange yellow or pink red flowers. Grows gregariously in shade ; fairly common. Lailongsong, 510 m., June 1961, *Deb* 25819 ; Kothong, June 1961, *Deb* 26048 ; Khonsa-Laju, June 1961, *Deb* 25983 ; Kothong, June 1961, *Deb* 26046.

Gnaphalium luteoalbum Linn.

A herb with yellow flowers in moist slopes or cultivated land. Chenglang, *Murthy* 12922 ; Chennhang, June 1961, *Deb* 26191.

Lactuca rostrata (Bl.) O. Kuntze

A herb with heads ; rare. Kothong, June 1961, *Deb* 26049, Khonsa-Laju, June 1961, *Deb* 25995.

L. gracilis DC.

Herb with yellow flowers ; scarce. Wakka, July 1961, *Deb* 26524.

Laggera pterodonta Benth.

A herb of moist soil with mauve coloured flowers ; rare. Chenglang-Khela, March 1958, *Murthy* 12942.

Mikania cordata (Burm. f.) Robin.

A twining weed of *Jhum* land ; very common. Namchick, Oct. 1959, *Rao* 20188.

Myriactis nepalensis Less.

Herb with dull white flowers ; scarce. Noglo, June 1961, *Deb* 26355.

M. wallichii DC.

An annual herb with yellowish white head ; scarce. Nampong-Pangsupass, Oct. 1959, *Rao* 20151.

Sonchus arvensis Linn.

A herb with axillary and terminal inflorescence ; rare. Raho-Wakka, June 1961, *Deb* 26480.

Spilanthus acmella (Linn.) Murr.

A herb with yellowish ligulate florates head ; scarce. Namchick, Oct. 1959, *Rao* 20175.

Vernonia volkameriaefolia DC.

A tall shrub with brown head ; common. Pungchow, July 1961, *Deb* 26586.

Wedelia wallichii Less.

An annual herb with yellow flowers ; common. Noglo, June 1961, *Deb* 26369.

Xanthium strumarium Linn.

An undershrub in fruit ; scarce. Jairampur, Oct. 1959, *Rao* 19986.

Youngia japonicum (L.) DC.

Herb with pink flowers ; rare. Chennhang, June 1961, *Deb* 26198.

(*to be continued*)

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Family Thomisidae

Genus *REGILLUS* Cambridge 1884

341. **Regillus elephantus** Tikader 1966. *Proc. Indian Acad. Sci.* **64** : 54.

Distribution : India : Shillong, Assam.

Type : **ZSI.**

Genus *RUNCINIA* Simon 1875

342. **Runcinia escheri** Reimoser 1934. *Revue Suisse. Zool.* **14** : 487.

Distribution : India : Andhra Pradesh.

Type : ?

343. **Runcinia roonwali** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 278.

Distribution : India : Poona, Maharashtra ; Shillong, Assam.

Type : **ZSI.**

Genus *SYNAEMA* Simon 1864

344. **Synaema brunettii** Tikader 1962. *J. Linn. Soc. London* **44** : 578 fig. 10.

Distribution : India : Darjeeling, West Bengal.

Type : **ZSI.**

345. **Synaema decorata** Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 174, fig. 2a-c.

Distribution : India : West Bengal ; Mysore; Maharashtra.

Type : **ZSI.**

Genus *STRIGOPLUS* Simon 1885

346. **Strigoplus netravati** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 252 ; fig. 3a, b.

Distribution : India : Chikmagalur district, and South Kanara district, Mysore.

Type : ZSI.

Genus *THOMISUS* Walckenaer 1805

347. **Thomisus beautifularis** Basu 1963. *J. Asia. Soc. Bengal* **5** : 23.

Distribution : India : Calcutta, West Bengal.

Type : ZSI.

348. **Thomisus bulani** Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 178.

Distribution : India : Calcutta, West Bengal.

Type : ZSI.

349. **Thomisus cherapunjeus** Tikader 1966. *Proc. Indian Acad. Sci.* **64** : 55.

Distribution : India : Shillong, Cherapunjee, Assam.

Type : ZSI.

350. **Thomisus dhakuriensis** Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 180.

Distribution : India : West Bengal.

Type : ZSI.

351. **Thomisus elongatus** Stoliczka 1869. *J. Asia. Soc. Bengal* **38** : 227.

Distribution : India : West Bengal.

Type : ZSI.

352. **Thomisus katrajghatus** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 259.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

353. **Thomisus lobosus** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 285.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

354. **Thomisus memae** Sen and Basu 1963. *Sci. and Cult.* **29** : 515.
Distribution : India : West Bengal.
Type : ZSI.

355. **Thomisus peelianus** Stoliczka 1869. *J. Asia. Soc. Bengal* **38** : 226.
Distribution : India : Sibsagar, Assam.
Type : ZSI.

356. **Thomisus pooneus** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 283.
Distribution : India : Poona, Maharashtra.
Type : ZSI.

357. **Thomisus projectus** Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 182.
Distribution : India : West Bengal.
Type : ZSI.

358. **Thomisus pugilis** Stoliczka 1869. *J. Asia. Soc. Bengal* **38** : 225.
Distribution : India : West Bengal ; Madras ; Punjab.
Type : ZSI.

359. **Thomisus shivajiensis** Tikader 1965. *Proc. Indian Acad. Sci.* **61** : 284.
Distribution : India : Poona, Maharashtra.
Type : ZSI.

360. **Thomisus shillongensis** Sen 1963. *Sci. and Cult.* **29** : 610.
Distribution : India : Shillong, Assam.
Type : ZSI.

361. **Thomisus sikkimensis** Tikader 1962. *J. Linn. Soc. London* **44** : 570, fig. 5a-c.
Distribution : West Sikkim.
Type : ZSI.

362. **Thomisus sorajaii** Basu 1963. *Sci. and Cult.* **29** : 606.
Distribution : India : West Bengal.
Type : ZSI.

Genus *THANATUS* Koch 1837

363. **Thanatus dhakuricus** Tikader 1960. *J. Bombay nat. Hist. Soc.* **57**: 177, fig. 4.

Distribution : India : Calcutta, West Bengal.

Type : ZSI.

364. **Thanatus lanceoletus** Tikader 1966. *Rec. Indian Mus.* **59** (4) : 443.

Distribution : India : Bikaner, Rajasthan.

Type : ZSI.

365. **Thanatus mandali** Tikader 1965. *Sci. and Cult.* **31** : 39, fig. 1a, b.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

Genus *TIBELLUS* Simon 1895

366. **Tibellus chaturshingi** Tikader 1962. *J. Poona Univ. Sci. and Tech.* **22** : 133, fig. 1.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

367. **Tibellus elongatus** Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 176, fig. 3a, b.

Distribution : India : West Bengal ; Poona, Maharashtra.

Type : ZSI.

368. **Tibellus katrajghatus** Tikader 1962. *J. Poona Univ. Sci. and Tech.* **22** : 136, fig. 3.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

369. **Tibellus poonaensis** Tikader 1962. *J. Poona Univ. Sci. and Tech.* **22** : 134, fig. 2.

Distribution : India : Poona, Maharashtra.

Type : ZSI.

Genus *TMARUS* Simon 1875

370. **Tmarus kotigeharus** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 250, fig. 2a-c.

Distribution : India : Mysore ; Maharashtra ; Shillong, Assam.

Type : ZSI.

Genus *XYSTICUS* Koch 1835

371. **Xysticus hindustanicus** Basu 1963. *J. Asia. Soc. Bengal* **5** : 23.
Distribution : India : Dum Dum, Calcutta, West Bengal.
Type : ZSI.

372. **Xysticus joyantius** Tikader 1966. *J. Asia. Soc. Bengal* **8** (4) : 3.
Distribution : India : Khasi and Jaintia Hills, Assam.
Type : ZSI.

373. **Xysticus kamakhyai** Tikader 1962. *J. Linn. Soc. London* **44** : 575, fig 7.
Distribution : India : Shillong, Assam.
Type : ZSI.

374. **Xysticus kashidi** Tikader 1963. *Proc. Indian Acad. Sci.* **58** : 261, fig. 11.
Distribution : India : Mysore.
Type : ZSI.

375. **Xysticus mandali** Tikader 1966. *Proc. Indian Acad. Sci.* **64** : 58.
Distribution : India : Shillong, Assam.
Type : ZSI.

376. **Xysticus minutus** Tikader 1960. *J. Bombay nat. Hist. Soc.* **57** : 173.
Distribution : India : West Bengal ; Poona, Maharashtra ; Shillong, Assam.
Type : ZSI.

377. **Xysticus pynurus** Tikader 1966. *J. Asia. Soc. Bengal* **8** (4) : 1.
Distribution : India : Khasi and Jaintia Hills, Assam.
Type : ZSI.

378. **Xysticus roonwali** Tikader 1964. *Rec. Indian Mus.* **59** (3) : 264.
Distribution : Nepal and Sikkim.
Type : ZSI.

379. **Xysticus shillongensis** Tikader 1962. *J. Linn. Soc. London* **44** : 578.
Distribution : India : Shillong, Assam.
Type : ZSI.

380. **Xysticus shyamrupus** Tikader 1966. *Proc. Indian Acad. Sci.* **64** : 57.

Distribution : India : Shillong, Assam.

Type : **ZSI.**

381. **Xysticus sujatai** Tikader 1962. *J. Linn. Soc. London* **44** : 577.

Distribution : India : Shillong, NEFA.

Type : **ZSI.**

Family UROCTEIDAE

Genus *UROCTEA* Dufour 1820

382. **Uroctea indica** Pocock 1900. FAUNA BRIT. INDIA *Arachnida*, p. 243, fig. 83.

Distribution : India : Western India, Poona, Maharashtra.

Type : **BMNH.**

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Vegetation of Pachpadra Salt Basin in Western Rajasthan

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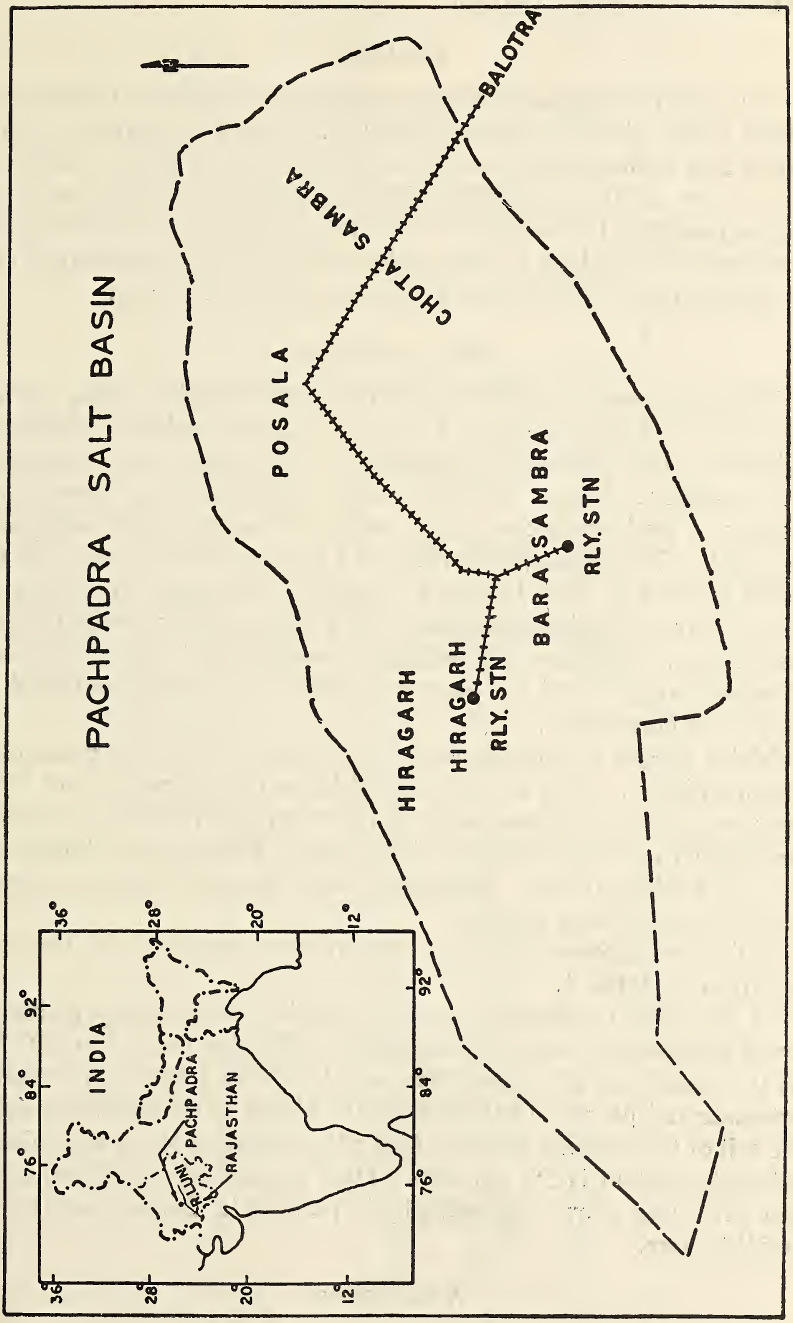
(*With a map*)

INTRODUCTION

Saline and sodic soils are widespread and extensive in the arid regions of India and form a conspicuous part of the landscape. Pachpadra Salt Basin is one such area where common salt is produced on a commercial scale. Divergent views regarding the origin of Salt have been expressed by Godebole 1951, Auden 1952, Holland & Christie 1909, and Ghose (1964). The area possesses sparse and specialised vegetation due to high salinity and where grasses grow, these are heavily grazed. Development of such areas for the production of palatable grasses is necessary in view of the acute shortage in cattle forage. No detailed information is available about the vegetation and flora of this basin except in the pioneer work of Blatter & Hallberg (1918-1921), Puri *et al.* (1964), Bhandari (1967), Satyanarayan & Shankarnarayan (1963), for central Luni Basin. The list of plants species along with a short description of vegetation of Pachpadra Salt Basin is presented in this paper.

LOCATION AND TOPOGRAPHY

The study area situated about 16 km to the west of River Luni and about 3 km in the same direction from the town of Pachpadra is an oval basin about 11-13 km long and 2-3 km wide in a sandy valley. It has a south-westerly course parallel to Luni River for several kilometres and then turns eastwards and joins the river. The eastern edge of the valley is capped by occasional hills and sand dunes sloping towards the Luni River, while to the west the sand dunes form an unbroken line. The total area of the basin is 32·3 sq km. The rain water leaches the salt from a catchment area of 560-640 sq km and carries it in to the subsoil of the shallow basin. About 1120 salt extraction pits are scattered all over this area, but the largest number lies in the western portion called


PACHPADRA SALT BASIN
BALOTRA
CHOTA SAMBRA
POSALA
BARA SAMBRA
RLY. STN
HIRAGARH
HIRAGARH
RLY. STN
INDIA
PACHPADRA
RAJASTHAN
R. LUNI
36°
28°
20°
12°
76°
84°
92°

Hiragarh. Pits of the eastern part are generally silted up and abandoned. At present 428 pits are worked.

CLIMATE

The climate is typical of Western Rajasthan (Parmanik, Hariharan & Ghose 1952). Average annual rainfall is 300 mm but is erratic and uncertain as is evident from the fact that in 1892 it was as high as 1200 mm and as low as 20 mm in 1889. Sand storms are prevalent during the months preceding the monsoon. The area is very dry and weather conditions generally speaking are reasonably good for the manufacture of salt, the average rate of evaporation being some 12·5 cm monthly.

SOIL AND BIOTA

The soil is sandy to sandy-clay-loam in texture, highly saline, overlaid by stable sand dunes and sand sheet of varying thickness (10-80 cm), giving the area a hummocky appearance. The sand cover is calcareous but non-saline. Heavy textured soils are present in depressions. Shallow to moderately deep loamy sand overlies the saline sandy clay loam soils. The brine springs occur at a depth of 5 to 6·5 m. The soil profile consists of thick layers of sand with intermittent thin layers of silt and clay of varying thickness. The brine stratum lies within coarse sandy layers. Zonation of these layers indicate that it was a salt marsh of undated origin, and has now been filled up to its present level by deposits of blown sand.

Major part of the area is occupied by grasses due to the presence of subsoil moisture. They sprout very quickly at the commencement of the monsoon, but are very soon eaten up by the large population of livestock the majority of which belong to the nomadic, *Banjaras*, who inhabit the area for trading in salt. Because of such constant grazing pressure grasslands are of poor quality.

Soils from different communities have been analysed and the results are given in table 1.

In the three representative profiles, the hummocky sandy plains are low in calcium carbonate content and the pH value varies from 7·7-7·9. On the abandoned pits sandy clay soils have 0·75-1·8 per cent calcium carbonate and pH value 8·0-8·9 but have higher water holding capacity. The soil of the working pit has a high pH reaching up to 9·3 and calcium carbonate content is 5·7 per cent. High amount of soluble salts, and high pH value allow only halophytic plants like *Suaeda fruticosa* to establish there.

VEGETATION

Blatter & Hallberg (1918-1921) mentioned a few halophytic species, Biswas & Rao (1953) listed halophytic species of Rajputana desert.

TABLE 1

SOIL ANALYSIS OF PACHPADRA SALT BASIN

S. No.	Location, Habitat and grass community	Soil depth cm.	pH	Ec. micromhos cm	Mechanical composition			$CaCO_3$ %	Organic matter %
					Sand	Silt	Clay		
1	Sandy hummocky plain (Posali) with *Dactyloctenium sindicum*, *Eleusine compressa*	0-30	7·7	6800	89·4	3·8	5·0	0·8	0·3
		30-60	7·9	6400	87·3	4·5	6·3	0·6	0·5
		60-100	7·8	5400	90·7	4·3	4·8	0·9	0·2
2	Abandoned pit (Hiragarh) *Sporobolus marginatus—Cyperus rotundus—Dichanthium annulatum*	0-30	8·9	4500	82·1	3·5	8·3	1·4	0·4
		30-60	8·0	3700	78·2	4·5	10·8	1·8	0·0
		60-100	8·0	5000	82·1	7·0	6·8	0·8	0·1
3	Working pit (Posali) No vegetation	Top	7·9	4400	85·1	1·8	5·3	3·4	0·1
		Middle	9·3	3900	87·1	3·3	4·3	5·7	0·1
		Bottom	8·3	9500	84·8	1·8	5·3	3·8	0·2

Shantisarup (1958) studied the halophytes of Luni river-bed in relation to soil structure and composition. Recently Bhandari (1968) studied the flora of Western Rajasthan but no complete account has ever been made from this region.

The following habitats have been recognised based on the floristic survey of the region. 1. Sandy plain, (a) Flat older alluvial plain and (b) Undulating hummocky plain, 2. Saline depression, 3. Salt pit, (a) Working salt pit and (b) Abandoned pit either completely filled or partially filled up and, 4. Sand dunes. The floristic composition of each type is as follows :—

1. Sandy plain

(a) *Flat older alluvial plain :* A part of the basin occupies this habitat with deep sand cover and loose top. Soils are calcareous and carbonate content increases with depth. It is dominated by a plant community of *Prosopis juliflora* DC. with 90 per cent relative dominance. Main associate is *Salvadora persica* L. The ground is occupied by a grass community of *Sporobolus-Eleusine-Cenchrus* sp. with 5-7 per cent basal cover.

(*b*) *Hummocky older alluvial plain :* A major portion of the basin is covered by undulating topography with loose soil on the top. The vegetation cover is very sparse and distributed in patches. *Acacia jacquemontii-P. julflora* community dominates with 65 and 30 per cent relative dominance. *Dactyloctenium scindicum-Eleusine compressa* is the grass community supported by this habitat with 5·4 per cent basal cover. The percentage composition of these two grasses is 57·7 and 18·6 per cent respectively. About 13 species have been recorded with *Zygophyllum simplex* as main associate. In this habitat one can rarely see *Lycium barbarum* due to the large scale extermination for the crystallization of salt. At present it is transported from the adjoining areas and hence large scale plantation of this species should be encouraged in the tract.

2. Saline depression

These are low lying patches which either occur in the interdunal areas or between two or more pits. Here the soils are heavier, deep, sandy-clay-loam, and highly saline. Fringes of these areas are occupied by a community of *Salvadora persica-Tamarix dioica* with 55 and 35 per cent relative dominance respectively. *Sporobolus marginatus-Cenchrus setigerus* is the grass community with 6·6 per cent basal cover.

3. Salt pit

(*a*) *Abandoned pits :* These are the old pits which are either fully or partially covered by gradual silting. These are surrounded by a community of *Prosopis juliflora-Salvadora oleoides* with 85 and 15 per cent relative dominance. Some of the partially filled salt pits act as temporary ponds and support a pure community of *Fimbristylis ferruginea* (L.) Vahl. *Acacia nilotica* ssp. *indica* and *Suaeda fruticosa* (L.) Forsk. are the two chief associates.

(*b*) *Working pits :* Pits where salt is extracted. Practically devoid of any shrub vegetation. *Tragus biflorus-Aristida funiculata-Eleusine compressa* is the grass community with 3 per cent cover.

4. Sand dune

Medium to high, stabilised, transverse and longitudinal dunes demarcate the boundary of the basin. Few dunes are located in the basin itself. In the residential colony, office building and other small huts on the dunes are dominated by a community of *Calotropis procera.* Boundary dunes are generally cultivated for kharif crops. *Salvadora oleoides-Acacia jacquemontii-C. procera* form a sparse community while the ground community of grass is that of *Cenchrus biflorus-C. prieurerii* with two per cent cover. Stray plants of *Calligonum polygonoides* need mention.

ANNOTATED LIST OF PLANTS COLLECTED

The list of plants collected from the basin follows Bentham and Hooker's system of classification. Popular vernacular names, short description, time of flowering and fruiting and exact locality are given for each species. Based on available literature the nomenclature has been made up to date. The number after the description of each species refer to Herbarium sheets stored at the Herbarium of Central Arid Zone Research Institute, Jodhpur, India. A visual estimation of the plant species and their distribution on different habitat of the Basin has been given in Table 2.

TABLE 2

DISTRIBUTION OF PLANT SPECIES ON DIFFERENT HABITATS AT PACHPADRA SALT BASIN

Species	Habitat				
	Loose sandy soils	Saline depression	Working pits	Old pits	Dunes
TREES					
Salvadora oleoides Decne.	—	—	—	R	R
S. persica L.	—	—	R	A	—
Prosopis cineraria (L.) MC. bride	—	—	—	—	R
P. juliflora DC.	—	R	R	A	—
Maytenus emarginata (Willd.) Dinght-Hou.	—	—	—	—	C
Acacia nilotica (L.) Del. ssp. *indica* (Benth) Branan.	—	—	—	R	—

TABLE 2 (*Contd*).

Species	Habitat				
	Loose sandy soils	Saline depression	Working pits	Old pits	Dunes
SHRUBS					
Acacia jacquemontii Benth.	A	—	—	—	R
Calotropis procera R.Br.	F	—	—	R	A
Capparis decidua (Forsk.) Edgew.	R	—	—	R	A
Zizyphus nummularia (Burm. f.) Wt. & Arn.	F	—	—	—	—
Leptadenia pyrotechnica Decne.	R	—	—	—	—
Tamarix dioica Roxb.	R	—	C	R	—
Calligonum polygonoides L.	—	—	—	—	C
Lycium barbarum L.	R	—	—	—	R
Suaeda fruticosa Forsk.	C	C	A	F	—
Haloxylon salicornicum Bunge ex Boiss.	C	—	R	R	—
Salsola baryosma (Schult.) Dandy	F	R	C	C	—
UNDER-SHRUBS					
Aerva persica (Burm. f.) Merrill.	F	—	—	R	A
A. pseudotomentosa Blatt. & Hallb.	A	—	—	R	C
Crotalaria burhia Buch.-Ham.	C	—	R	R	F
Sericostoma pauciflorum Stocks	—	—	—	—	R
HERBS					
Tephrosia purpurea (L.) Pers.	C	R	R	C	C
Convolvulus microphyllus Sieb. ex Spreng.	C	—	—	—	R
Tribulus alatus Delile	R	—	—	—	—
T. terrestris L.	A	—	—	—	R
Cressa cretica L.	R	A	F	C	—
Zygophyllum simplex L.	C	F	A	C	—
Citrullus vulgaris Schrad.	R	—	—	—	C
C. colocynthis (L.) Schrad.	—	—	—	—	C
Amaranthus spinosus L.	C	—	—	—	—
Portulaca oleracea L.	R	A	F	R	—
Trianthema decandra L.	A	F	—	F	—
Cleome gynandra (L.) Briquet.	A	—	—	—	—
GRASSES					
Sporobolus marginatus Hochst. ex A. Rich.	A	C	C	C	—
S. helvolus (Trin.) Dur et Schinzt.	A	C	C	C	—
Dichanthium annulatum (Forsk.) Stapf	R	F	—	A	—
Dactyloctenium sindicum Boiss.	A	—	F	R	R
Cenchrus ciliaris L.	C	R	C	C	F
C. setigerus Vahl	C	—	C	A	C
Eleusine compressa (Forsk.) Asch. ex Schw.	A	—	R	C	F
Aeluropes lagopoides (L.) Trin. ex Thw.	—	A	—	C	—
Aristida funiculata Trin. et Rupr.	A	—	C	A	C
Cenchrus biflorus Roxb.	C	—	—	R	A
SEDGES					
Cyperus rotundus L.	C	A	C	A	C
C. laevigatus C. B. Clarke	C	—	—	—	A
Fimbristylis ferruginea (L.) Vahl	—	—	—	A	—

A=Abundant, C=Common, F=Frequent, R=Rare.

MENISPERMACEAE

Cocculus pendulus (Forsk.) Diels (Vern. Pilwan)

A large woody climber, common on *Salvadora persica* L. and *Tamarix dioica* Roxb. Flower greenish yellow; Oct.-Feb. Common around abandoned pits. Hiragarh. (*Saxena* 2542).

BRASSICACEAE

Farsetia hamiltoni Royle (Vern. Pilang)

40-45 cm high, slender, annual herb. Flower white; July-Oct. Fruit papery. Common on deep sandy soils. Hiragarh siding-2. (*Saxena* 2574).

CAPPARIDACEAE

Capparis decidua (Forsk.) Edgew. (Vern. Kair)

1-2 m tall spiny, leafless shrub. Flower deep orange red; July-Sept. and March-May. On loose sandy soil and hummocky plain. Hiragarh. (*Saxena* 2583) .

Cleome gynandra (L.) Briquet (Vern. Bagra)

40-45 cm. high, annual herb. Flower white to creamy; July-Sept. Common on loose sandy soils near habitation. Posala siding-3. (*Saxena* 2649).

POLYGALACEAE

Polygala erioptera DC. (Vern. Chota Bekharia)

15-25 cm high, procumbent annual herb. Flower whitish pink to violet; July-Dec. Circuit House. (*Saxena* 2529).

PORTULACACEAE

Portulaca oleracea L. (Vern. Noonkhuri, Lunki, Noonia)

A prostrate, succulent herb. Flower yellow; Aug.-Nov. Common on saline depressions and abandoned pits. Hiragarh pit 296. (*Saxena* 2587).

TAMARICACEAE

Tamarix dioica Roxb. (Vern. Faras, Jhau)

1-2 m tall shrub. Flower pink; Aug.-Dec. Common on water logged saline areas and abandoned pits. Hiragarh siding-2. (*Saxena* 2535).

MALVACEAE

Abutilon indicum D. Don (Vern. Tarakanchi, Dabi, Jhili)

60-80 cm tall undershrub. Flower yellow; Aug.-Dec. Growing under shade of *S. persica* L. on abandoned pit. Bara Samra pit 288. (*Saxena* 2671).

Hibiscus punctatus Dalz.

90-100 cm tall suffruticose undershrub. Flower pale rose; Aug.-Dec. Hiragarh siding-3. (*Saxena* 2585).

Sida ovata Forsk. (Vern. Bila)

30-40 cm high, woody perennial. Flower yellow; Aug.-Dec. Circuit House. (*Saxena* 2528).

TILIACEAE

Corchorus depressus (L.) Stocks (Vern. Kagla-ki-tamaku, Hadu-ka-Khet)

Small, woody, perennial herb. Flower yellow; July-Dec. Hiragarh siding-2. (*Saxena* 2568).

C. tridens L. (Vern. Kagla-ki-tamaku, Hadu-ka-khet)

20-30 cm high, annual herb. Flower yellow; Aug.-Nov. Hiragarh and Posala. (*Saxena* 2649, 2538).

ZYGOPHYLACEAE

Tribulus alatus Delile (Vern. Bokhra)

Procumbent to spreading herb. Flower light yellow, fruit winged; Aug.-Dec. Common on sandy soil. Posala siding-3. (*Saxena* 2644).

T. terrestris L. (Vern. Kanti)

A prostrate annual herb. Flower bright yellow, fruit spiny; July-Nov. Common on sandy plains. Posala siding-3. (*Saxena* 2643).

Zygophyllum simplex L. (Vern. Lunwa, Lunio)

20-30 cm high or procumbent, annual herb. Stem yellow to violet red. Flower yellow; July-Nov. Abundant on pit wall and inter pit areas. Hiragarh siding-2. (*Saxena* 2547).

There are two strains in the locality, one with pure yellow and the other with violet-red stem. Both were recorded growing side by side.

MELIACEAE

Azadirachta indica Juss. (Vern. Neem)

A cultivated tree around Barabbangla and office. Bara Bangla. (*Saxena* 2678).

CELASTRACEAE

Maytenus emarginata (Willd.) Ding Hou (Vern. Kangkeran)

3-4 m tall, spiny tree. Flower pinkish white, ripe fruit light purple ; Oct.-Jan. On sandy gravelly soil and sand dunes. Hiragarh boundary dune. (*Saxena* 2624).

RHAMNACEAE

Zizyphus nummularia (Burm. f.) Wt. & Arn. (Vern. Bordi)

1-2 m tall, spiny shrub. Flower pale whitish, ripe drupe red ; Aug.-Dec. Hiragarh siding-2. (*Saxena* 2536).

PAPILIONACEAE

Alhagi pseud-alhagi (M. Bieb.) Desv. (Vern. Jawasa)

30-40 cm high, spiny undershrub. Flower red ; Oct.-Feb. On abandoned pits and saline areas. Hiragarh. (*Saxena* 2597).

Crotalaria burhia Buch.-Ham. ex Benth (Vern. Sannia)

60-80 cm high, spreading perennial undershrub. Flower yellow ; Aug.-March. Common on sandy soils. Hiragarh. (*Saxena* 2556).

Indigofera cordifolia Heyne ex Roth (Vern. Bekar, Bekario)

20-30 cm long, prostrate to procumbent, annual herb. Flower pinkish red. Pod 2-seeded ; July-Nov. Common on sandy soils. Circuit House. (*Saxena* 2526).

I. linifolia (L.) Retz. (Vern. Bekri, Bekar)

Small, wiry, annual herb. Flower pink. Pod globose, one-seeded ; Aug.-Nov. Hiragarh boundary dune. (*Saxena* 2614).

I. hochstetteri Baker (Vern. Bekrio)

30-40 cm long, prostrate to procumbent annual herb. Flower pinkish. Pod flat ; Aug.-Nov. Common on sandy soil. Hiragarh siding-2. (*Saxena* 2537).

I. linnaei Ali (Vern. Bekar)

20-30 cm high, prostrate to procumbent, woody herb with pink flowers. Pod 2-3 seeded Aug.-Dec. Common on loose sandy soils. Hiragarh. (*Saxena* 2527).

I. oblongifolia Forsk. (Vern. Goila)

80-100 cm tall, pubescent shrub. Flower pink to orange pink. Sept.-Feb. Common on abandoned pits. Hiragarh. (*Saxena* 2635).

Phaseolus trilobus Ait. (Vern. Panri, Jangli moth)

20-30 cm long, trailing, annual herb. Flower bright light yellow. Pod 6-8 seeded ; Aug.-Oct. Rare on sandy soils. Hiragarh Boundary dune. (*Saxena* 2618).

Tephrosia purpurea (L.) Pers. (Vern. Dhamasia, Sarphunka)

30-60 cm tall biennial or perennial undershrub with violet pink to red flowers. Pod flat ; July-Nov. Abundant on sandy plain. Hiragarh siding-2. (*Saxena* 2567).

Sesbania bispinosa (Jacq.) Fawe & Rend. (Vern. Ekar)

80-120 cm tall, soft-wooded shrub. Flower yellow with reddish spot ; July-Nov. Frequent on old pit walls. Hiragarh siding-2. (*Saxena* 2575).

Heylandia latebrosa DC. (Vern. Gorakh-batti, Sonda)

20-25 cm long, prostrate to procumbent, annual herb. Flower yellow ; Aug.-Nov. On dry pit walls. Bara Samra Pit 288. (*Saxena* 2667).

Psoralea odorata Blatt. & Hallb. (Vern. Goir, Guir)

30-50 cm high, perennial undershrub. Flower pinkish violet ; Aug.-March. On abandoned pits only. Hiragarh siding-2. (*Saxena* 2661).

CAESALPINACEAE

Cassia obtusa Roxb. ex W. & A. (Vern. Beephini)

60-75 cm tall, woody undershrub. Flower pale yellow. Pod flat & wrinkled ; Aug.-Dec. On abandoned pit. Hiragarh. (*Saxena* 2633).

Cassia siamea Lamk.

A cultivated tree with reddish glaucous branches. Flower yellow ; July-Dec. Circuit House. (*Saxena* 2681).

MIMOSACEAE

Acacia nilotica (L.) Del. ssp. **indica** (Benth.) Bernan (Vern. Babul)

Thorny tree. Flower heads yellow. Pods tomentose; Aug.-Nov. and March-May. Frequent on fringes of abandoned pit. Chota Samra. (*Saxena* 2576)

Acacia jacquemontii Benth. ex Hook. (Vern. Bawli)

1-2 m tall, armed shrub. Flower heads yellow; Aug.-Dec. Common on sandy hummocky soils. Hiragarh siding-2. (*Saxena* 2645).

Albizzia lebbek (L.) Benth. (Vern. Siris)

A large tree. Flower greenish white to white. Pod long flat. Good top-feed species. Cultivated around office and quarters.

Prosopis cineraria (L.) Mac. bride (Vern. Khejri)

6-8 m tall, spiny tree. Flower yellow; Aug.-Dec. and March-July. Common on sandy soils. A good top-feed plant. Hiragarh. (*Saxena* 2595).

P. juliflora (Swarti) DC. (Vern. Vilayti babul, vilayti bawli)

3-5 m tall, spiny tree. Catkin yellow. Pods eaten by goats; Aug.-May. Hiragarh. (*Saxena* 2544).

CUCURBITACEAE

Blastiniaf imbristipula (Fenzl) Kotschy et Peyr. (Vern. Ankh-phutni-bel)

A large climber on *Capparis decidua* (Forsk.) Edgew. and *Salvadora* bushes. Flower white, fruit globose; Aug.-Nov. Hiragarh siding-2. (*Saxena* 2689).

Citrullus colocynthis (L.) Schrad. (Vern. Tastumba, Tumba)

1-2 m long trailing perennial herb. Flower light yellow; Aug.-Dec. Common on sandy soil and sand dunes. Seeds utilized for oil extraction. Bara Samra. (*Saxena* 2613).

C. vulgaris (L.) Schrad. (Vern. Matera)

1-2 m long trailing, annual herb. Flower yellow, fruit juicy with white or pinkish pulp; Aug.-Dec. Natural as well cultivated. Oil is extracted from seed. Hiragarh boundary dune. (*Saxena* 2612).

Coccinia grandis (L.) Voigt. (Vern. Ankh-phutni bel)

Large perennial climber on *Capparis*, *Zizyphus* and *Salvadora* bushes. Flower white, fruit bright scarlet; Aug.-Dec. Hiragarh siding-2. (*Saxena* 2631, 2537).

Cucumis callosus (Rottp.) Cogn. (Vern. Kachri)

1-2 m trailing, scabrid herb. Flower yellow; Aug.-Nov. Posala. (*Saxena* 2684).

AIZOACEAE

Gisekia pharnaceoides L. (Vern. Sardi, Morang)

10-20 cm long, prostrate to sub-erect annual herb. Stem pinkish-red; July-Oct.

Glinus lotoides L. (Vern. Badka)

10-15 cm high, spreading herb. Flower greenish white; Aug.-Dec. Common on silted pits. Pachpadra. (*Shankarnarayan* 1845).

Sensuvium sesuvioides (Fenzl.) Verde (Vern. Lonia)

10-15 cm long, procumbent annual herb. Flower axillary, red to pink; Aug.-Dec. Common on saline heavy soils. Pachpadra. (*Shankarnarayan* 1126, 1221).

Trianthema portulacastrum L. (Vern. Safedsanter, Sarta)

20-30 cm long prostrate, succulent, annual herb. Flower axillary solitary; Aug.-Dec. Pachpadra. (*Shankarnarayan* 1222).

T. decandra L. (Vern. Sarta, Sato, Santar)

20-30 cm long, prostrate, annual herb. Flower red, fruit violet-pink; Aug.-Dec. On loose sandy soils with some organic content. Rly. Station. (*Saxena* 2633).

T. triquetra Willd. ex Rottl. (Vern. Lunia, Lunaki)

10-20 cm long prostrate, annual herb. Flower greenish white; Aug.-Dec. Common on low lying areas. Hiragarh boundary dune. (*Saxena* 2608).

ASTERACEAE

Eclipta prostrata L. (Vern. Jalbhangra)

20-40 cm long, prostrate, annual herb. Floral heads white; Aug.-Feb. Common on old silted pits. Bara Samra. (*Saxena* 2661).

Glossocardia bosvallia (L.f.) DC.

8-15 cm long, prostrate, annual herb. Flower head yellow; Oct.-Jan. Pachpadra. (*Shankarnarayan* 1856).

Dichotoma tomentosa Cass. (Vern. Vajradanti)

20-30 cm high, spiny, annual herb. Floral head spiny; Sept.-Dec. Frequent on sandy hummocky terrain. Hiragarh. (*Saxena* 2623 A).

Gnaphalium pulvinatum Delile (Vern. Kallali)

30-40 cm tall, woody perennial undershrub. Leaves whitish with wax coating. Flower heads yellow; Sept.-Jan. Common on silted pits. Hiragarh siding-3. (*Saxena* 2636).

Launaea chondrilloides Hook. f. (Vern. Dudhia)

10-30 cm tall, perennial herb with yellow juice. Heads terminal and yellow; Oct.-Feb. Frequent on silted pits. Bara Samra. (*Saxena* 2666).

L. nudicaulis Hook. f. (Vern. Janglio-gobhi)

15-30 cm tall, perennial herb. Floral heads yellow. Achenes thickly ribbed; Oct.-Feb. Frequent on silted pit. Bara Samra. (*Saxena* 2665).

Pulicaria angustifolia DC. (Vern. Soneli)

20-30 cm high, annual herb. Floral heads deep yellow; Aug.-Feb. Common on sandy soil. Hiragarh siding-3. (*Saxena* 2636, 2525).

P. wightiana (DC.) Benth. ex Clarke (Vern. Sonela, Soneli)

30-45 cm tall, annual herb. Flower heads bright yellow; Sept.-Feb. Frequent on sandy soil. Pachpadra. (*Shankarnarayan* 247).

Vernonia cineraria (L.) Less. (Vern. Phulni, Shadair)

20-30 cm tall, annual, hairy herb. Flower heads pinkish violet, white at maturity; Aug.-Dec. Common on silted pit walls. Bara Samra. (*Saxena* 2670).

V. cinerascens Sch.-Bip. (Vern. Bari phulni, Lalia)

50-70 cm tall, woody, spreading undershrub. Flower heads purple violet; Aug.-Nov. Common on silted pit surface. Hiragarh pit 85. (*Saxena* 2637).

Voluterella ramosa (Roxb.) Sant. (Vern. Lin-katmanda, Telkant)

20-30 cm high, spiny, much branched herb. Flower heads pink; Aug.-Dec. Common on sand dunes. Hiragarh boundary dune. (*Saxena* 2626).

SALVADORACEAE

Salvadora oleoides Decne. (Vern. Mitha-jal)

3-5 m tall tree. Flower white. Drupe orange yellow; Jan.-June. Bara Bangla dune. (*Saxena* 2659).

S. persica L. (Vern. Khara-jal)

4-7 m tall tree. Flower white, fruit violet red ; Dec.-June. Plenty around old and silted pits. Hiragarh siding-2. (*Saxena* 2541).

ASCLEPIADACEAE

Calotropis procera (Ait.) R.Br. (Vern. Ak, Akda, Akra)

1-2 m tall, perennial undershrub. Flower whitish-violet ; Aug.-Jan. Common around old pit and hummocky areas. Hiragarh siding-3. (*Saxena* 2594).

Leptadenia pyrotechnica (Forsk.) Decne. (Vern. Khimp, Khinmpra)

1-1.5 m tall, leafless undershrub. Flower yellowish green ; Aug.-Dec. Frequent on hummocky areas. Bara Samra. (*Saxena* 2679).

GENTINACEAE

Enicostomma verticillatum (L.) Engl. (Vern. Jalbhangra)

Small, procumbent herb. Flower yellow ; Sept.-Jan. Hiragarh boundary dune. (*Saxena* 2620).

BORAGINACEAE

Arnebia hispidissima (Lehm) DC. (Vern. Rambas)

20-25 cm high, suberect herb. Root violet red. Flower yellow ; Sept.-March. Rare on sandy soils. Hiragarh boundary dune. (*Saxena* 2615).

Heliotropium bacciferum Forsk. var. **subrosa** (Vern. Kalibui)

15-20 cm high, annual herb. Flower sessile, numerous in rigid spike ; Aug.-Nov. On silted pits. Pachpadra. (*Shankarnarayan* 1215).

H. paniculatum R. Br. (Vern. Kalibui)

25-30 cm high, annual herb. Flower white in cylindric raceme, fruit four lobed ; Aug.-Dec. On sandy soil. Hiragarh siding-3. (*Saxena* 2554).

H. strigosum Willd. (Vern. Choti-santri)

A scabrid, prostrate to procumbent herb. Flower white in elongated spike ; Aug.-Dec. Bara Bangla. (*Saxena* 2655).

H. subulatum Hochst. ex DC (Vern. Kalibui)

30-40 cm high, perennial, woody herb. Flower pale white; Aug.-Dec. Common on moist sandy soil. Hiragarh boundary dune. (*Saxena* 2617).

Sericostoma pauciflorum Stocks (Vern. Kharsan, Kharsni)

30-40 cm tall, perennial undershrub, clothed with appressed hairs. Flower white; Aug.-March. On sand dunes only. Bara Bangla dune. (*Saxena* 2654).

Trichodesma indicum R. Br. (Vern. Sal-kanta, Phuldar)

20-30 cm high, hispid herb. Flower light blue; Aug.-March. Pachpadra salt basin. (*Shankarnarayan* 1138).

CONVOLVULACEAE

Convolvulus microphyllus Sieb. ex Spreng. (Vern. Phulwati, Santri, Kerjan).

30-35 cm long, prostrate to procumbent, perennial herb. Flower white or light pink; Aug.-Jan. Common on sandy soil. Hiragarh siding-3. (*Saxena* 2695, 2586).

Cressa cretica L. (Vern. Lana, Ovindo, Kharia)

10-15 cm high, procumbent, annual herb. Flower white in small axillary clusters; Aug.-Jan. Abundant on saline soils. Hiragarh siding-2. (*Saxena* 2555).

Ipomoea pes-tigridis L. (Vern. Panwa, Pherwana)

60-70 cm long, twining, annual herb, clothed with spreading hairs. Flower whitish pink on sessile heads; Aug.-Dec. On moist sandy places. Bara Samra. (*Saxena* 2669).

I. verticillata Forsk. (Vern. Chirawri)

40-60 cm long, prostrate, annual herb. Flower white; Aug.-Nov. Common on shady places. Chota Samra. (*Saxena* 2676, 2684).

SOLANACEAE

Lycium barbarum L. (Vern. Murali, Morali)

1-2 m tall, spinous, shrub. Flower white solitary or in fascicle; Aug.-Jan. On hummocks and dunes. Hiragarh. (*Saxena* 2639).

Physalis minima L. (Vern. Janglo-bheri)

40-60 cm long, prostrate, perennial herb. Flower creamy ; Sept.-Dec. On moist shady places below *S. ersica* tree. Hiragarh pit 85. (*Saxena* 2634).

Scrophulariaceae

Anticharis senegalensis (Walp.) Bhand.

30-45 cm high, branched, annual herb. Flower reddish-violet ; Aug.-Dec. On sandy saline soils. Hiragarh siding-2. (*Saxena* 2558).

Striga angustifolia (D. Don) Saldhana (Vern. Misso)

20-30 cm high, annual herb. Flower in the axil of floral bract ; July-Oct. Bara Samra. (*Saxena* 2665).

Acanthaceae

Justicia vahlii Roth (Vern. Kagnero, Mokrogas)

20-30 cm high, slender, annual herb. Flower violet-pink ; Aug.-Dec. On moist shady places. Hiragarh. (*Saxena* 2680).

Blepharis sindica T. Anders. (Vern. Bhangri)

Small, spiny undershrub. Flower bluish ; Aug.-Nov. On sandy gravelly soils. Hiragarh siding-2. (*Saxena* 2548).

Peristrophe bicalyculata (Retz.) Nees (Vern. Kagner)

80-100 cm tall, perennial herb. Flower deep violet-pink ; July-Oct. Frequent under the shade of trees. Hiragarh siding-3. (*Saxena* 2539).

Labiatae

Leucas urticaefolia (Vahl) R. Br. [Vern. Goma (Hindi)]

25-30 cm high, hairy, annual herb. Flowers white, in globose terminal heads ; Aug.-Dec. Common on sandy soils. Bara Samra. (*Saxena* 2638).

Nyctaginaceae

Boerhaavia diffusa L. (Vern. Chelavri, Pawa, Sata)

50-70 cm long, trailing perennial herb. Flower light to dark pink ; July-March. Common on sandy soils. Posala. (*Saxena* 2641).

B. repanda Willd. (Vern. Bara-sata)

1-1·5 m long, climbing, perennial herb. Flower pink; July-Feb. Common on moist shady places. Posala. (*Saxena* 2646).

B. elegans Choisy (Vern. Chirio-panio)

25-35 cm high, annual herb. Stem dichotomously and panicle trichotomously branched; July-Sept. On old working pits. Hiragarh siding-2. (*Saxena* 2672).

AMARANTHACEAE

Achyranthus aspera L. (Vern. Unda-kanta, Andhajaro, Narkanta)

40-60 cm tall herb. Flower whitish pink, deflexed against large rachis, fruit prickly; Aug.-Dec. Among bushes in shady places. Hiragarh siding-2. (*Saxena* 2540).

Aerva persica (Burm. f.) Merrill (Vern. Bui, Buida)

40-80 cm tall, woody, perennial undershrub with thick tomentum. Greenish white spike; Oct.-Feb. Common. Hiragarh siding-2. (*Saxena* 2566).

A. pseudotomentosa Blatt. & Hallb. (Vern. Choti-Bui)

60-100 cm tall, woody perennial. Panicle leafy; Sept.-March. Hiragarh pit 85. (*Saxena* 2632).

Amaranthus spinosus L. (Vern. Kateli-cholai)

40-60 cm high, spiny herb. July-Oct. On waste places near habitation. Bara Bangla. (*Saxena* 2606).

Digera muricata (L.) Mart. (Vern. Laler, Latoor, Lulero)

20-30 cm high, annual herb. Flower deep pink in lax spike; Aug.-Oct. Common on sandy soils. Hiragarh siding-2. (*Saxena* 2580).

CHENOPODIACEAE

Salsola baryosma (Roem. et Schult.) Dandy (Vern. Jerio-lana, Iani)

0·8-1·2 m high, much branched undershrub. Flower in short cylindric spike; Oct.-Jan. Common in the area. Hiragarh. (*Saxena* 2627, 2543).

Suaeda fruticosa Forsk. (Vern. Kala-lana, Lunki)

0·8-1·5 m high, diffusedly branched undershrub. Leaves thick & fleshy, turn black on drying; July-Dec. Abundant on saline soils, salt pit and silted up pits. Hiragarh siding-2. (*Saxena* 2577, *Shankarnarayan* 1130, 1180, 1217, 1849).

Haloxylon salicornicum Bunge ex Boiss. (Vern. Sajjio-lano, Lana)

1-1·5 m tall, much branched, leafless shrub. Flower yellow; Oct.-March. On loose sandy soils. Chota-Samra. (*Saxena* 1673).

POLYGONACEAE

Calligonum polygonoides L. (Vern. Phoog, Phogra)

1-1·5 m tall, leafless shrub. Stem reddish woody. Flower pinkish white; Feb.-June. On boundary dunes. Hiragarh boundary dune. (*Saxena* 2672).

EUPHORBIACEAE

Euphorbia granulata Forsk. (Vern. Dudhi)

10-20 cm long, prostrate, annual herb. Leaves coriacious; Aug.-Oct. Common on sandy soils. Hiragarh siding-2. (*Saxena* 2569).

E. jodhpurensis Blatt. & Hallb. (Vern. Duheli)

10-15 cm high, slender, procumbent, annual herb. Capsule trilocular; Aug.-Oct. Common on sandy soils. Posala. (*Saxena* 2652).

Phyllanthus fraternus Webster

20-30 cm high annual herb. Stipule peltate; Aug.-Dec. Common on moist sandy soils. Circuit house. (*Saxena* 2530).

P. maderaspatensis L. (Vern. Hazardana)

40-60 cm tall, annual herb. Flower axillary, greenish; Aug.-Jan. Hiragarh. (*Saxena* 2596).

LILIACEAE

Aloe barbadensis Mill (Vern. Guar-patta)

A cultivated succulent under-shrub with dense, aggregate of narrow leaves.

CYPERACEAE

Cyperus laevigatus L. =*C. arenarius* Retz. (Vern. Motha)

15-30 cm high, sedge with creeping rhizome; Aug.-Dec. Common on loose sandy soils. Hiragarh boundary dune. (*Saxena* 2611).

C. bulbosus Vahl (Vern. Motto Mothrio)

15-25 cm high, perennial, rhizomatous sedge, bulbous root. Spike violet-red; Aug.-Dec. Common on sandy soil. Hiragarh pit 204, (*Saxena* 2604).

C. rotundus L. (Vern. Motha)

20-45 cm high, perennial, rhizomatous sedge. Flower spike brownish-red; Aug.-Jan. Abundant on silted pits. Hiragarh siding-2. (*Saxena* 2562, 2592).

C. tuberosus Rottb.

0·9-1·2 m tall, rhizomatous, perennial, amphibious sedge. Spike red when mature; Aug.-Dec. Common on water logged area. Posala siding-3. (*Saxena* 2642).

Fimbristylis ferruginea (L.) Vahl

40-45 cm tall, perennial, amphibious sedge. Spike umbellate, spikelets, pale brown; Sept.-March. Common on semi-silted pits. Chota-Samra. (*Saxena* 2675).

POACEAE

Aeluropus lagopoides (L.) Trin. ex Thw. (Vern. Kharia-ghas)

30-80 cm long, trailing grass with convolute leaves. Spike terminal; Aug.-Dec. Common on clayey saline soils or rann. Hiragarh siding 2. (*Saxena* 2628, *Shankarnarayan* 1851).

Aristida adscenscionis L. var. **adscenscionis** (Vern. Lump, Lompra)

40-60 cm tall, diffused annual grass. Awn dark blackish on maturity; Aug.-Oct. Common on sandy soils. Hiragarh siding-2. (*Saxena* 2673).

A. funiculata Trin. et Rupr. (Vern. Lomp, Lompra)

25-40 cm high, slender, annual grass. Awn very troublesome; July-Oct. Abundant on sandy soils. Hiragarh siding-2. (*Saxena* 2565).

A. funiculata Trin. et Rupr. var. **mallica** (Edgew.) Henr. (Vern. Lompra)

40-50 cm high, annual grass. Awn bigger than in *funiculata* and troublesome; July-Nov. Posala. (*Saxena* 2642).

A. mutabilis Trin. & Rupr. (Vern. Lompra)

45 cm tall, annual grass. Spikelets brown; July-Sept. Common on sandy soils. Posala (*Saxena* 2581).

Brachiaria ramosa (L.) Stapf (Vern. Kuri)

20 cm high, procumbent to spreading, annual grass. Spikelets turgid; Aug.-Oct. Frequent on moist soils. Hiragarh siding-2. (*Saxena* 2552, *Shankarnarayan* 1214).

Cenchrus biflorus Roxb. (Vern. Bhurut)

30-40 cm high, annual grass. Involucres echinate spiny ; July-Oct. Common on sandy soils. Hiragarh siding. (*Saxena* 2563).

Cenchrus ciliaris L. (Vern. Safed-Dhaman, Anjan)

A tussocky perennial grass. Involucre not spiny ; Aug.-Dec. Common on old pit walls on sandy soil. Three different strains have been recorded :

1. 60-70 cm tall ; spike 8-10 cm long, violet on ripening (*Saxena* 2598).
2. 25-30 cm tall ; with small clump. Spike 4-5 cm long, light violet on ripening. (*Saxena* 2599).
3. Same as No. 2. Spike colourless on ripening. (*Saxena* 2571, 2579).

C. prieurii (Kunth) Maire. (Vern. Dhaman)

40-50 cm high, annual grass. Long spike ; Aug.-Nov. Common on sandy soils. Hiragarh siding-2. (*Saxena* 2549).

C. pennisetiformis Hochst. et Steud. ex Steud. (Vern. Dhaman)

50-90 cm tall, perennial grass ; Aug.-Dec. Rare on moist sandy soils. Hiragarh. (*Saxena* 2599)

C. setigerus Vahl (Vern. Kala Dhaman)

30-50 cm high, perennial tussocky grass. Spike of various colours, some lax while others compact ; Aug.-Dec. Common on sandy soils of the old pits. Three distinct strains have been recognized :

1. 30 cm tall, small, tussocky grass. Common on alluvial plain. (*Saxena* 2601).
2. 30-45 cm tall, small tussocky grass. On old pit walls. (*Saxena* 2589).
3. 70-110 cm tall, large tussocky grass. Rare on moist shady places. (*Saxena* 2650). Hiragarh pit 296, Hiragarh siding-3 and Posala. (*Saxena* 2601, 2589, 2650).

Chloris virgata Sw. (Vern : Gharnia-ghas)

24-30 cm tall, annual grass. Digits 4-5 rayed. Blackens when ripe ; Aug.-Dec. Common on saline soils. Hiragarh pit 296. (*Saxena* 2602).

Dactyloctenium aegyptium (L.) P. Beauv. (Vern. Kuri, Makro, Mansa)

15-20 cm tall suberect spreading annual. Digits 3-4 rayed ; Aug.-Oct. Common on sandy, clay, loam, soils. Rly. Station. (*Saxena* 2534).

Dactyloctenium sindicum Boiss. (Vern. Makra, Ganthia ghas)

25-40 cm tall small tussocky perennial. Stolons rooting at nodes; Aug.-Dec. On hummocky terrain. Circuit House. (*Saxena* 2525).

Desmostachya bipinnata (L.) Stapf (Vern. Dab)

40-60 cm tall, perennial, tussocky grass. Spike in long raceme; Aug.-Feb. Common on moist sandy soils. Hiragarh siding-2. (*Saxena* 2549).

Dichanthium annulatum (Forsk.) Stapf (Vern. Karad)

50-90 cm tall, perennial, tussocky grass. Spike reddish to brown purple; Aug.-Dec. Common on silted pits. A very good fodder grass. Hiragarh pit 85. (*Saxena* 2630).

Digitaria adscendens (H.B.K.) Henr. (Vern. Tara, Kuri)

25-35 cm high, slender annual grass with terminal spike, highly palatable; Aug.-Oct. Hiragarh siding-2. (*Saxena* 2550).

Echinochloa colonum (L.) Link (Vern. Soma, Homa)

A decumbent annual grass. Stem violet-red; July-Nov. On moist clayey soils or on semi-silted pits. Bara Samra pit 288. (*Saxena* 2664).

Eleusine compressa (Forsk.) Asch. ex Schw. (Vern. Tantia, Gandil)

Stoloniferous, trailing perennial grass. Spike 4-5 digitate; July-Dec. Common on hummocky terrain. A very good sheep grass. Hiragarh siding-2. (*Saxena* 2557).

Enneapogon brachystachys (Jaub. et Spach.) Stapf

8-10 cm tall, small tufted, perennial grass. Spike 2-3 cm long; July-Oct. On gravelly soils. Circuit House. (*Saxena* 2653).

Eragrostis ciliaris (L.) R. Br. (Vern. Chirio-ghas)

15-20 cm tall, annual grass. Spike solitary; July-Dec. Common on sandy soil. Hiragarh boundary dune. (*Saxena* 2570).

E. poaeoides P. Beauv. (Vern. Chirioro-ghas)

20-35 cm tall, annual grass. Culm shining, bluish white; Aug.-Nov. Common on sandy soils. Hiragarh boundary dune. (*Saxena* 2626).

E. tremula Hochst. ex Steud. (Vern. Kiria, Phunkia)

30-35 cm tall, annual grass. Spike in lax panicle; July-Nov. On sandy soils. Hiragarh pit 85. (*Saxena* 2621).

Lasiurus sindicus Henr. (Vern. Sewan)

40-60 cm tall, stoloniferous, woody perennial grass. Spike terminal; Aug.-Feb. On dune bases. Hiragarh boundary dune. (*Saxena* 2619).

Latipes senegalensis Kunth (Vern. Kuri)

20-30 cm tall, annual grass. Stem light pink on maturity ; Aug.-Dec. Hiragarh siding-2. (*Saxena* 2560).

Melanocenchris jacquemontii Jaub. et Spach. (Vern. Phoolia, khargose-chutti)

10-15 cm tall, annual grass. Spike lax and woolly ; Aug.-Nov. Common on sandy soils of old pits. Hiragarh siding-2. (*Saxena* 2578).

Panicum antidotale (L.) Retz. (Vern. Gramna, Girona)

100-150 cm tall, tussocky, perennial grass. Spike long in lax panicle ; Aug.-Feb. Recorded in bushes of *Capparis decidua*. Hiragarh siding-3. (*Saxena* 2582).

Panicum turgidum Forsk. (Vern. Murut)

70-100 cm tall, tussocky perennial grass. Old culm woody ; Aug.-Dec. On dunes and hummocks. Hiragarh pit 265. (*Saxena* 2593).

Sporobolus coromandelianus (Retz.) Kunth

20-25 cm tall, densely tufted annual grass ; Aug.-Dec. On gravelly soils. Hiragarh siding-2. (*Saxena* 2553).

S. helvolus (Trin.) Dur. et Schniz. (Vern. Deva, Lunagas, Kharia)

40-70 cm high, tufted perennial grass ; Aug.-Dec. Common on sandy saline and clayey soils. Hiragarh siding-2. (*Saxena* 2564).

S. marginatus Hochst. ex A. Rich. (Vern. Deva, Kharia-ghas)

40-60 cm tall, tussocky perennial grass. Panicle pyramidal ; Aug.-Feb. Common in the area. Hiragarh siding-2. (*Saxena* 2564).

Schoenofeldia gracilis Kunth (Vern. Tarwaria)

30-45 cm high, slender, annual grass. Spike terminal ; Aug.-Oct. On low lying saline soils. Hiragarh siding-2. (*Saxena* 2576).

Tetrapogon tenellus (Roxb.) Chiov.

30-40 cm high, annual grass ; Aug.-Nov. Common on gravelly soils under protection. Hiragarh siding-3. (*Saxena* 2588).

Tragus biflorus (Roxb.) Schult. (Vern. Sitagas, Charchada)

6-10 cm high, annual grass ; July-Oct. On gravelly soils. Hiragarh siding-2. (*Saxena* 2572).

EPHEDERACEAE

Ephedra foliata Boiss. (Vern. Lanra)

A straggling climber recorded on *Capparis* and *Lycium* bushes. Bhandari (1954) described in detail its distribution in Western Rajasthan.

SYNOPSIS OF SALT BASIN FLORA

Out of 58 families, 226 genera and 440 species recorded indigenous in Western Rajasthan. 36 families covering 97 genera and 137 species are collected from Pachpadra Salt Basin. Thirteen families have only single species viz. Menispermaceae, Brassicaceae, Polygalaceae, Portulacaceae, Tamaricaceae, Meliaceae, Celastraceae, Rhamnaceae, Gentinaceae, Labiatae, Polygonaceae, Liliaceae and Ephedraceae, Poaceae (Graminae) has the maximum genera (34) while Papilionaceae (12) and Asteraceae (Compositae) (11) stand second and third respectively.

ACKNOWLEDGEMENTS

The authors are indebted to Dr. T. R. Mehta, Director, Central Arid Zone Research Institute, Jodhpur, for his guidance and constructive criticism. Thanks are also due to Dr. B. B. Roy, Head of Division of Basic Resource Studies, for encouragement, guidance and facilities for this work. Our thanks to Dr. M. M. Bhandari, Lecturer, University of Jodhpur, for his help in identification of some specimens.

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Effects of temperature and salinity on the oxygen consumption in clams

BY

M. R. RANADE

(*With eight text-figures*)

The importance of oxygen as an oxidizing agent in energy releasing mechanism is well known. Utilization of oxygen is, therefore, a direct measure of degree of activity, food conversion and heat production (Bishop 1950). In lamellibranchs, which are filter-feeders, the current of water drawn through the inhalent siphon is used for feeding and respiration. The fluctuations in the estuarine environment where clams are found, are, therefore, bound to influence the oxygen-consumption in clams. Dam (1935, 1954) has studied oxygen utilization in *Mya arenaria* and scallops. Berkeley (1921, 1923) has studied anaerobic respiration in pelycypod mollusks. Mitchell (1912) and Hazelhoff (1938) have given oxygen requirements of shellfish and other invertebrates. Galtsoff & Whipple (1930) have investigated the oxygen-consumption in normal and green oysters under different conditions. The oxygen-consumption of tissues in *Venus merceraria* has been studied by Hopkins (1948).

Amongst various other factors that affect oxygen-consumption, the influence of body size and temperature on respiration of some animals has been studied by Kleiber (1947), Zeuthen (1947, 1953), Scholander *et al.* (1953), Rao & Bullock (1954) and Dawson *et al.* (1956). But most of these studies are made on the arctic and temperate forms. Wolvekamp & Waterman (1960) have reviewed respiration in crustacea. Studies on oxygen-consumption in tropical poikilotherms have recently attracted attention (Job 1955, Saroja 1959, and Parvatheswararao 1959, 1960).

The influence of salinity on oxygen-consumption has been studied by Bloch and Schlieper (1953) in *Asterias rubens*, Eliassen (1952) in *Artemia salina*, Potts (1954) in brackish and fresh water animals, Schlieper (1955) in *Mytilus edulis*, Lofts (1956) in *Palaemonetes varians* and Gross (1957) in some decapod crustacea. The only work of this type in tropical species is that of Gopalkrishna (1953) on penaeid prawns and Rao

(1958) on *Metapenaeus monoceros*. No work has been done on the oxygen-consumption in clams from tropical waters. The present investigation was, therefore, undertaken with a view to studying the effects of temperature and salinity on the oxygen-consumption in the common clams *Meretrix meretrix* and *Katelysia opima*.

MATERIALS AND METHODS

Clams collected from Kalbadevi estuary were stored in the same manner as described in the earlier paper (Ranade & Kulkarni 1972). For determining oxygen-consumption in clams, the method adopted by Saroja (1959) was followed, except that instead of a cork to close the respiratory chamber, a three centimetre layer of liquid paraffin was put on the surface of the water to stop gaseous exchange between the sea water in the respiratory chamber and the atmosphere as suggested by Galtsoff & Whipple (1930).

Temperature being an important factor in controlling the rate of oxygen-consumption, care was taken to keep the required temperature constant, with a variation of only ± 1°C, by providing a thermostat. Observations on the rate of oxygen-consumption were made at three different temperatures namely 20, 30 and 40°C at a constant salinity (34‰). The temperature of the water available in the laboratory varied between 28° and 30°C. For measuring oxygen-consumption at 40°C, the respiratory-chamber was kept in an aquarium tank filled with water, heated to 40°C by means of a heater and maintained at this level by a 'Sunvic' thermostat. For obtaining a temperature of 20°C, ice was used in the aquarium tank in which the respiratory-chamber was kept and the tank in turn was kept in a thermocole insulated box.

The differential values of oxygen in the samples of water from the respiratory-chamber before and after the experimental period i.e. one hour, gave the amount of oxygen consumed. The clams were taken out immediately after the experiment and shelled. The wet weight of the flesh was taken after removing the extra water by using a blotting paper.

In order to study the effect of salinity on the oxygen-consumption, observations were made at three different salinities namely 34%, 25·5% and 17%, which was equal to 100%, 75% and 50% sea water respectively. In these experiments the temperature was kept constant at 30°C. The lower grades of salinities were prepared as usual, by diluting sea water with distilled water.

As the clams remain buried in the sand in the natural habitat, the respiratory-chamber was painted black, to avoid activity of clams on account of light. The oxygen contents of water were determined by Winkler's method as described by Barnes (1959).

ANALYSIS OF DATA

The rate of oxygen-consumption was plotted as a function of body weight (weight-specific) on a double logarithmic grid. Such a plot over an adequate weight range gives a straight line with a negative slope (Dehnel 1960).

The regression of oxygen-consumption on body weight assumes a form :

$$O_2 = aW^b \ldots\ldots$$

$$\text{or } \operatorname{Log} O_2 = \operatorname{Log} a + b \operatorname{Log} W.$$

where O_2 is the volume of oxygen consumed in ml, W is the weight of the body in grams and a and b are constants being respectively the intercept and the slope of the line or the exponent. The regression of oxygen-consumption on body weight at three different temperatures and salinities were calculated separately.

RESULTS

Results of the oxygen-consumption at various temperatures in both the species are summarised in Tables I and II and are plotted as size metabolism curves in Figs. 1 and 2.

TABLE I

TOTAL OXYGEN CONSUMPTION IN *M. meretrix* AT DIFFERENT BODY WEIGHTS AND AT DIFFERENT TEMPERATURES

S. No.	Weight in gm	Oxygen consumed ml/hr		
		20°C	30°C	40°C
1	0·40	0·16	0·30	0·42
2	0·60	0·17	0·28	0·43
3	1·00	0·30	0·42	0·54
4	1·25	0·36	0·51	0·60
5	1·58	0·45	0·60	0·68
6	1·99	0·57	0·66	0·80
7	2·51	0·75	0·78	0·83
8	3·16	0·93	0·96	0·95
9	4·00	1·14	1·17	1·15

TABLE II

TOTAL OXYGEN CONSUMPTION IN *K. opima* AT DIFFERENT BODY WEIGHTS AND AT DIFFERENT TEMPERATURES

S. No.	Weight in gm	Oxygen consumed ml/hr		
		20°C	30°C	40°C
10	0·54	0·35	0·40	0·55
11	0·85	0·38	0·46	0·58
12	1·03	0·49	0·65	0·69
13	1·52	0·65	0·80	0·85
14	2·00	0·80	1·05	1·15
15	2·25	0·95	1·08	1·19
16	3·02	1·05	1·38	1·24

Oxygen-consumption as a function of body size in relation to temperature :

From the study of the data given in Tables I and II it could be seen that the oxygen-consumption in clams increases with increase in body weight at all the temperatures studied. However, this increase in oxygen-consumption with increase in body weight is not the same at the three temperatures, which is apparent from the regression coefficients of the size metabolism curves. The regression coefficient of oxygen-consumption in relation to body size is maximal in both the species at 20°C and decreases as the temperature increases. The straight lines of the size metabolism curves also suggest that throughout the weight range studied the oxygen-consumption increases with the same power of body weight. From Tables I and II, it could be also seen that at any given temperature, the oxygen-consumption per unit of time is lesser in smaller clams than in larger ones.

From the curves given in Figs. 1 and 2 the values of weight specific QO_2 or the unit oxygen-consumption, (O_2 ml/gm/hr), were calculated for the representative weight of clams. These are given in Tables III and IV.

TABLE III

OXYGEN-CONSUMPTION PER GRAM OF BODY WEIGHT PER HOUR IN *M. meretrix* OF DIFFERENT WEIGHTS AND AT DIFFERENT TEMPERATURES

S. No.	Weight in gm	Oxygen ml/gm/hr 20°C	30°C	40°C
1	0·50	0·32	0·54	0·76
2	0·75	0·30	0·48	0·62
3	1·00	0·29	0·42	0·53
4	2·00	0·29	0·35	0·39
5	3·00	0·28	0·30	0·31
6	4·00	0·28	0·29	0·29

The values are calculated from the size metabolism curves presented in Fig. 1.

TABLE IV

OXYGEN-CONSUMPTION PER GRAM OF BODY WEIGHT PER HOUR IN *K. opima* OF DIFFERENT WEIGHTS AND AT DIFFERENT TEMPERATURES

S. No.	Weight in gm	Oxygen ml/gm/hr 20°C	30°C	40°C
7	0·50	0·54	0·72	0·94
8	0·75	0·48	0·60	0·74
9	1·00	0·45	0·55	0·66
10	2·00	0·39	0·43	0·45
11	3·00	0·38	0·42	0·42
12	4·00	0·32	0·32	0·32

The values are calcluated from the size metabolism curves presented in Fig. 2.

From Tables III and IV, it would be seen that the unit oxygen-consumption (O_2 ml/gm/hr) decreases with increasing body weights of clams at all temperatures studied. However, this decrease in unit oxygen-consumption is more conspicuous at 40°C and 30°C than at 20°C.

Oxygen-consumption as a function of temperature :

The values of regression coefficient ' b ' are given in Table V.

TABLE V

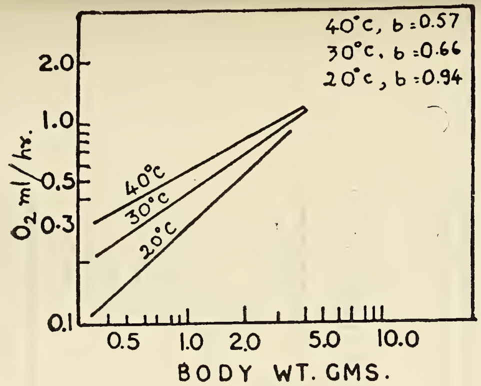
Species	Temperature		
	20°C	30°C	40°C
M. meretrix	0·94	0·66	0·57
K. opima	0·75	0·66	0·50

The size metabolism curves given in Figs. 1 and 2 show that the ' b ' (Table V) value decreases with increase in temperature and in *M. meretrix* is 0·94 at 20°C, 0·66 at 30°C and 0·57 at 40°C ; whereas in *K. opima* it is 0·75 at 20°C, 0·66 at 30°C and 0·50 at 40°C. This decrease in ' b ' value with increase in temperature indicates that the increase in oxygen-consumption in larger clams with increase in temperature is lesser than in smaller clams, and therefore, smaller clams can be regarded as more sensitive to temperature changes than the larger ones.

The unit oxygen-consumption values of clams of different weights are given in Tables III and IV and are plotted as rate-temperature curves in Figs. 3 and 4. The examination of these curves also indicates that the weight or body size of the clam is an important parameter in influencing the pattern of metabolic response at various temperatures. It will also be seen from these curves that the smaller clams are more sensitive to temperature changes than the larger ones in both the species studied. Thus in 1·00 gm clam of *Meretrix meretrix* the weight specific QO_2 rises from 0·42 to 0·53 when the temperature rises from 30°C to 40°C and drops from 0·42 to 0·29 when the temperature drops from 30°C to 20°C. The corresponding rise and fall in 3·00 gm clam is very much less. In case of *K. opima* also a similar trend is seen, the weight specific QO_2 rises from 0·55 to 0·66 with the rise in temperature from 30°C to 40°C and falls from 0·55 to 0·45 with the fall in temperature from 30°C to 20°C. The corresponding increase or decrease in case of 3·00 gm clam is much smaller.

Q_{10} as a function of temperature :

To describe the magnitude of temperature effect on respiratory processes, the frequently used expression Q_{10} is a convenient



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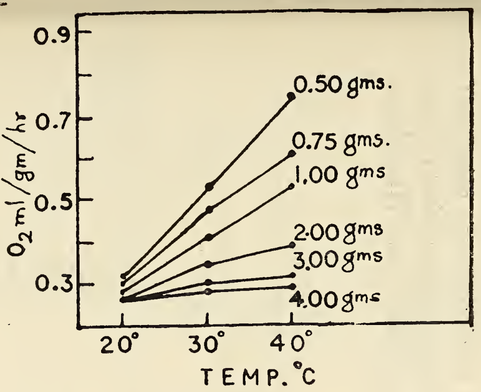

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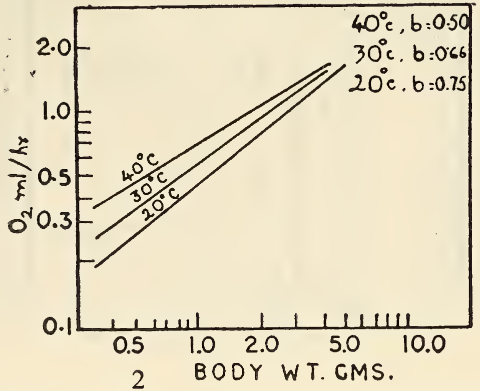

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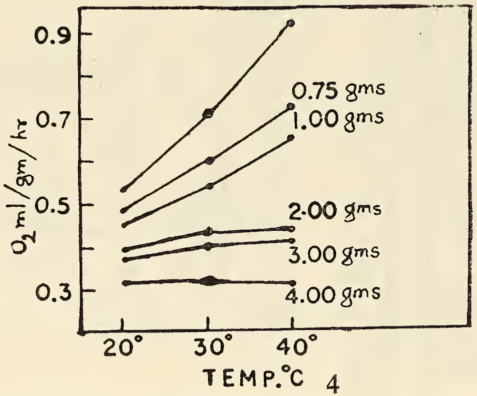

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FIG. 1. Total oxygen-consumption in *M. meretrix* as a function of body size at different temperatures. (20°C, 30°C and 40°C).
FIG. 2. Total oxygen-consumption in *K. opima* as a function of body size at different temperatures. (20°C, 30°C and 40°C).
FIG. 3. Rate of oxygen-consumption (O_2 ml/gm/hr) as a function of temperature in *M. meretrix*.
FIG. 4. Rate of oxygen-consumption (O_2 ml/gm/hr) as a function of temperature in *K. opima*.

measure over the biological temperature range. It is a factor by which a reaction velocity is increased for a rise of temperature of 10 degrees.

$$Q_{10} = (K_2/K_1)^{\frac{10}{t_1-t_2}}$$

where K_1 and K_2 are velocity constants corresponding to temperatures t_1 and t_2.

The Q_{10} values of oxygen-consumption in clams were calculated from the data given in Tables III and IV for various weights and at various temperatures studied. The same are given in Tables VI and VII and are plotted in Figs. 5 and 6.

TABLE VI

Q_{10} OF OXYGEN-CONSUMPTION IN *M. meretrix* IN RELATION TO BODY SIZE AND TEMPERATURE

S. No.	Weight in gm	20-30°C	30-40°C
1	0·50	1·70	1·40
2	0·75	1·60	1·29
3	1·00	1·40	1·26
4	2·00	1·26	1·15
5	3·00	1·07	1·03
6	4·00	1·03	1·00

The Q_{10} values are calculated from the data given in Table III.

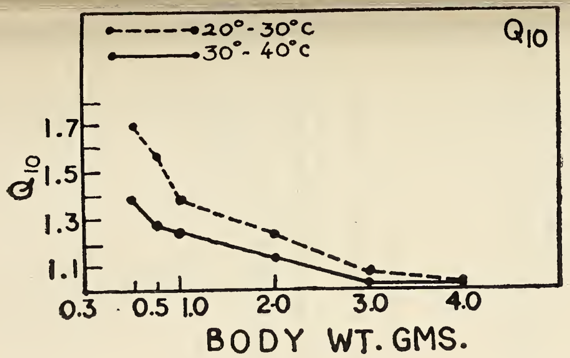
TABLE VII

Q_{10} OF OXYGEN-CONSUMPTION IN *K. opima* IN RELATION TO BODY SIZE AND TEMPERATURE

S. No.	Weight in gm	20-30°C.	30-40°C.
7	0·50	1·33	1·30
8	0·75	1·25	1·23
9	1·00	1·22	1·20
10	2·00	1·10	1·05
11	3·00	1·10	1·00
12	4·00	1·00	1·00

The Q_{10} values are calculated from the data given in Table IV.

In case of *M. meretrix* Q_{10} values are size dependent at all temperatures studied. It systematically decreases with increase in body weight at all the temperatures studied. However, this trend is more conspicuous at temperature range of 20-30°C than at 30-40°C. It will also be seen that the decrease in Q_{10} at both the temperature ranges is more marked



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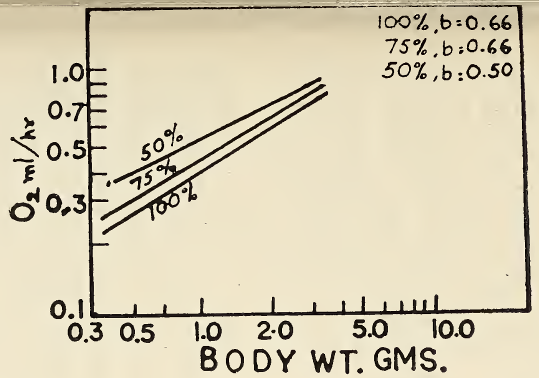

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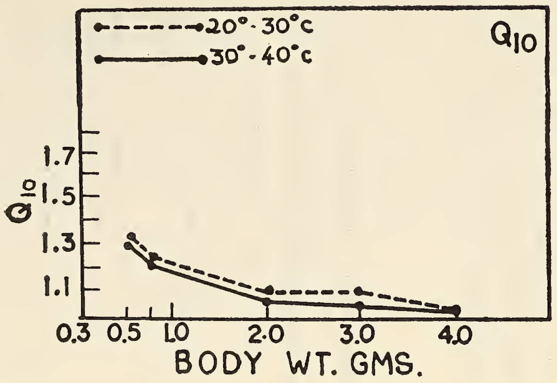

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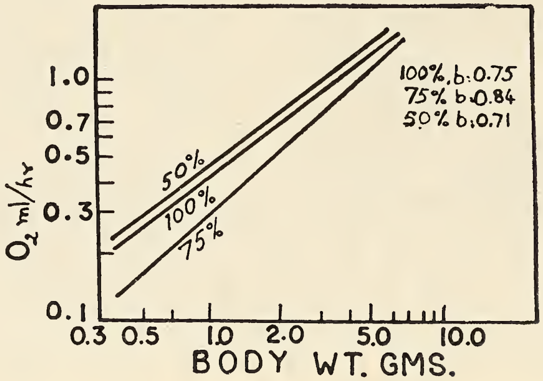

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FIG. 5. Q_{10} of oxygen-consumption in *M. meretrix* as a function of body size at different temperature ranges.
FIG. 6. Q_{10} of oxygen-consumption in *K. opima* as a function of body size at different temperature ranges.
FIG. 7. Total oxygen-consumption in *K. opima* as a function of body size at different salinities (100%, 75% and 50% sea water).
FIG. 8. Total oxygen-consumption in *M. meretrix* as a function of body size at different salinities (100%, 75% and 50% sea water).

in smaller clams than in the larger ones. Thus the Q_{10} between 0·50 gm and 2·00 gm clams, drops from 1·70 to 1·26 between 20-30°C and from 1·40 to 1·15 between 30-40°C whereas the corresponding drop between 2·00 and 4·00 gm clams is from 1·26 to 1·03 and 1·15 to 1·00 between temperatures 20-30°C and 30-40°C respectively. Similarly between 20-30°C and 30-40°C there is a decrease in Q_{10} from 1·70 to 1·40 in 0·50 gm clam whereas the corresponding decrease in 4·00 gm clam is from 1·03 to 1·00. This indicates that the Q_{10} of oxygen-consumption decreases with increasing temperature at all weights, such a decrease being once again more conspicuous in smaller clams than in larger ones. The higher values of Q_1 in smaller clams at all the temperature ranges studied suggests that they are more sensitive to temperature changes than the larger ones.

In case of *K. opima* also, a similar trend is seen. The Q_{10} decreases with increasing body weights at all temperatures studied. This decrease is more conspicuous at lower temperatures (20-30°C) than at higher temperatures (30-40°C). The decrease is also more marked in smaller clams than in larger ones. There is also a decrease in Q_{10} with increasing temperature, the decrease being more conspicuous in smaller clams than in larger ones. The higher values of Q_{10} in smaller clams suggests that they are more sensitive to temperature changes than the larger ones.

Oxygen-consumption as a function of body size in relation to salinity :

The results of oxygen-consumption at various salinities in both the species are summarised in Tables VIII and IX and are plotted as size metabolism curves in Figs. 7 and 8.

TABLE VIII

TOTAL OXYGEN-CONSUMPTION IN *K. opima* AT DIFFERENT BODY WEIGHTS AND AT DIFFERENT SALINITIES

S. No.	Weight in gm	Oxygen consumed ml/hr		
		100%	75%	50% sea water
1	0·60	0·29	0·36	0·45
2	1·03	0·45	0·51	0·58
3	1·52	0·52	0·59	0·66
4	1·98	0·63	0·70	0·79
5	2·20	0·70	0·81	0·87
6	3·02	0·85	0·95	1·26

TABLE IX

TOTAL OXYGEN-CONSUMPTION IN *M. meretrix* AT DIFFERENT BODY WEIGHTS AND AT DIFFERENT SALINITIES

S. No.	Weight in gm	Oxygen consumed ml/hr		
		100%	75%	50% sea water
7	1·00	0.40	0·32	0·52
8	1·25	0·50	0·38	0·58
9	1·58	0·62	0·46	0·70
10	2·00	0·73	0·58	0·80
11	2·51	0·86	0·75	0·96
12	3·16	0·95	0·96	1·10

From the data given in Table VIII it could be seen that the oxygen-consumption in *K. opima* increases with increasing body weight at all the salinities studied. However, the regression coefficients of the size metabolism curves presented in Fig. 7 show that the increase in oxygen-consumption with increase in body weight is not the same at all salinities studied. The regression coefficient of oxygen-consumption in relation to body size is maximal in 100% sea water (b=0·66) and decreases as the salinity decreases. The straight lines of the size metabolism curves also suggest that throughout the weight range studied, the oxygen-consumption increases with the same power of body weight. It is also evident from Table VIII that at any given salinity the oxygen-consumption per unit time is less in smaller clams than in larger ones.

In case of *M. meretrix* (Table IX), however, the trend is slightly different. The oxygen-consumption increases with increase in body weight at all the salinities studied. However, this increase in oxygen-consumption with increase in body weight is not the same at all the salinities studied. The regression coefficient of oxygen-consumption on body weight is maximal in 75% sea water (b=0·84) instead of in 100% sea water as in case of *K. opima.* The regression coefficient decreases as the salinity either increases above or decreases below 75% sea water. This is rather an interesting behaviour and will be discussed later. The straight lines of the size metabolism curves suggest that throughout the weight range studied, the oxygen-consumption increases with the same power of body weight. From Table IX it is also evident that at any given salinity the oxygen-consumption per unit time is less in smaller clams than in larger ones.

From the curves given in Figs. 7 and 8 the values of weight specific QO_2 or the unit oxygen-consumption (O_2 ml/gm/hr) were calculated for the representative weights of clams. These are given in Tables X and XI.

TABLE X

OXYGEN-CONSUMPTION PER GRAM BODY WEIGHT PER HOUR IN *K. opima* OF DIFFERENT WEIGHTS AND AT DIFFERENT SALINITIES

S. No.	Weight in gm	Oxygen ml/gm/hr		
		100%	75%	50% sea water
1	0·50	0·56	0·64	0·81
2	0·75	0·46	0·53	0·65
3	1·00	0·37	0·44	0·50
4	2·00	0·32	0·35	0·39
5	3·00	0·30	0·31	0·32
6	4·00	0·30	0·31	0·32

The values are calculated from the size metabolism curves presented in Fig. 7.

TABLE XI

OXYGEN-CONSUMPTION PER GRAM BODY WEIGHT PER HOUR IN *M. meretrix* OF DIFFERENT WEIGHTS AND AT DIFFERENT SALINITIES

S. No.	Weight in gm	Oxygen ml/gm/hr		
		100%	75%	50% sea water
7	0·50	0·52	0·36	0·62
8	0·75	0·48	0·34	0·56
9	1·00	0·40	0·32	0·50
10	2·00	0·34	0·27	0·40
11	3·00	0·33	0·25	0·37
12	4·00	0·31	0·25	0·33

The values are calculated from the size metabolism curves presented in Fig. 8.

From Table X it could be seen that in *K. opima* the unit oxygen-consumption decreases with increasing body weight at all the salinities studied, such a decrease being more conspicuous in 50% and 75% sea water than in 100% sea water. However, in *M. meretrix* (Table XI) though the unit oxygen-consumption decreases with increasing body weight at all salinities, the decrease is more conspicuous in 50% and 100% than in 75% sea water.

Oxygen-consumption as a function of salinity :

The values of regression coefficient ' b ' are given in Table XII.

TABLE XII

Species	Percentage of sea water		
	100%	75%	50%
K. opima	0·66	0·60	0·50
M. meretrix	0·75	0·84	0·71

The size metabolism curves given in Figs. 7 and 8 show that the ' b ' value of the curve varies with the salinity. In *K. opima* the 'b' value decreases with decrease in salinity which is 0·66 in 100%, 0·60 in 75% and 0·50 in 50% sea water. This decrease in 'b' value with decrease in salinity indicates that the increase in oxygen-consumption in larger clams with decrease in salinity is less than in smaller clams and can, therefore, be regarded as being more sensitive to salinity changes than the larger ones.

As stated above in case of *M. meretrix* the ' b ' value is maximal in 75% sea water (b=0·84) and decreases above (b=0·75) and below (b=0·71) this concentration. This decrease in 'b' value on either side of 75% sea water also appears to be on account of the less increase in oxygen-consumption in larger clams than in smaller ones with the change in the salinity. The smaller clams can, therefore, be regarded as more sensitive to changes in salinity either decrease below or increase above 75% sea water.

The unit oxygen-consumption values given in Table X for *K. opima* indicate that the weight or body size is an important parameter in influencing the pattern of metabolic response at various salinities. The smaller clams are more sensitive to salinity changes than the larger ones. Thus in case of 0·50 gm clam the weight specific QO_2 rises from 0·56 to 0·64 and to 0·81 as the salinity decreases from 100% to 75% and to 50% sea water. However, the corresponding rise in 4·00 gm clam is very much less.

In case of *M. meretrix* (Table XI) the weight specific QO_2 drops from 0·52 to 0·36 in a 0·50 gm clam as the salinity drops from 100% to 75% sea water and then rises from 0·36 to 0·62 as the salinity further drops to 50% sea water. But the corresponding drop and rise in a 4·00 gm clam is much less. This also indicates that the smaller clams are more sensitive to changes in the salinity than the larger ones.

Discussion

It has been well established that the metabolism of animals is considerably influenced by body size and temperature, of the environment. Similarly the tendency for the rate of metabolism in animals to vary with some power of body weight has been recognised and discussed by Zeuthen (1947, 1953). There is a general concept that the weight specific QO_2 is higher for smaller animals than the larger ones when measured at a given temperature for a given species and, therefore, if the logarithm of rate of oxygen-consumption is plotted as a function of logarithm of weight a linear relationship is obtained.

On the basis of the magnitude of metabolic rate in relation to body size, Bertalanffy (1951) has classified animals into three major groups of metabolic types by using the slope of the regression line of the logarithm of metabolic rate against the logarithm of body weight. According to him the three types are :—

(1) respiration surface-proportional, the allometric line showing a slope of 2/3 ($b=0{\cdot}67$) ;

(2) respiration weight proportional ($b=1{\cdot}00$) and

(3) intermediate group which is neither surface nor weight proportional ($b > 0{\cdot}67$ and $b < 1{\cdot}00$).

However, the relationship of body size to metabolism has been a subject of controversy. In a majority of cases amongst fishes, Bishop (1950) and Fry (1957) have shown that the increase in oxygen-consumption with size is surface area dependent rather than weight dependent. On the other hand intermediate condition has been shown by Job (1955) in *Salvelinus fontinalis* ($b=0{\cdot}8$ to $0{\cdot}9$) and Parvatheswararao (1959) in *Eutoplus maculatus* ($b=0{\cdot}77$). Job (1955) has discussed the metabloic response to body size in fishes and states, ' it seems rather likely that the Pisces fall into at least two of the Bertalanffy's metabolic types, some being of the first group i.e. surface proportional and others of an intermediate type neither surface nor weight proportional'. However, Parvatheswararao (1960) found that in *Puntius sophoro* the increase in oxygen-consumption is nearly weight dependent ($b=0{\cdot}96$ and $0{\cdot}91$) nearabout the habitat temperature (25°C and 30°C). He has further shown the influence of temperature on this relation, the increase in oxygen-consumption following surface area dependence at 35°C ($b=0{\cdot}59$) and intermediate condition at 15°C ($b=0{\cdot}86$).

Studies on the different invertebrate groups have also revealed that the value of ' b ' changes within a group of animals and is not constant for the same species under different environmental conditions and at different developmental stages. This has been shown by Rao & Bullock (1954) and Zeuthen (1953). Thus for crustacea (Wolvekamp & Waterman

1960) the ' b ' is generally between 0·67 and 1·00 i.e. between surface proportional to weight proportional. Kruger (1952) and Saroja (1959) have shown that the oxygen uptake is proportional to surface area in case of *Eisenia foetida* and *Megascolex mauritii* respectively. Recently Conover (1960) has shown that in case of *Artemia salina* the regression coefficient varies from 0·67 at 5°C to 0·93 at 13°C indicating two very different metabolic types. Zeuthen (1953, Fig. 4) has plotted metabolism and body size in different animals from eggs or larvae into mature stages. In the figure he has shown that in case of *Mytilus* sp. the ' b ' value increases from 0·80 to 0·95 and then decreases to 0·65 as the animal grows.

In the present investigation it will be seen that in both the species studied the regression values ($b=0·66$) nearabout the habitat temperature (30°C) indicate that the increase in oxygen-consumption is surface area dependent, however, an intermediate condition is seen in *K. opima* at 20 and 40°C. and in *M. meretrix* at 40°C., whereas the latter species shows that the oxygen-consumption may follow weight dependence at 20°C.

From the size metabolism curves presented in Figs. 1 and 2 it will be seen that the oxygen-consumption in clams increases with the same power of body weight at any given temperature throughout the weight range studied. Conversely, the unit oxygen-consumption decreases with increasing body weight this decrease being marked at 40°C. Thus the unit oxygen-consumption in *M. meretrix* decreases from 0·76 to 0·29 at 40°C, whereas the corresponding decrease at 30°C and 20°C is only from 0·54 to 0·29 and 0·32 to 0·28 respectively, between 0·5 and 4·0 gm clam. Similarly the decrease in *K. opima* is from 0·94 to 0·32 at 40°C the corresponding decrease at 30° and 20°C being from 0·72 to 0·32 and 0·54 to 0·32, respectively in 0·5 and 4·0 gm clam. If we consider 30°C as the habitat temperature then it will be seen that the size metabolism curves for 40°C and 20°C (Figs. 1 and 2) considerably deviate from the curve for 30°C. There is widest displacement of curves between 30°C and 20°C in *M. meretrix*, and less so in *K. opima* than between 30°C and 40°C. The curve for 20°C has the maximum slope. The displacement of curves is also more conspicuous in younger clams than in larger ones indicating that the former ones are more sensitive to changes in temperature than the latter.

In both the species of clams, the regression coefficients of size metabolism curves are shown to be temperature dependent. The ' b ' values decrease with increasing temperature and appear to be correlated with the greater responsiveness of smaller clams than the larger ones. When the temperature is lowered (20°C) the curve towards lower weight ranges is pulled down, similarly when there is rise in temperature (40°C the curve rises mainly due to the more sensitive nature of smaller clams than the larger ones to changes in temperature. Therefore, the smaller clams have higher Q_{10} values at these two temperature ranges.

In case of both the species studied, the Q_{10} of oxygen-consumption is size dependent at all the temperatures, decreasing with increasing body weight, the dependence being more marked in lower temperature ranges than the higher ones. The Q_{10} also decreases with increasing temperature, the decrease being more marked in smaller clams indicating that they are more sensitive to changes in temperature than the larger ones. Rao & Bullock (1954) have shown that in many poikilotherms the Q_{10} decreases with increasing body weight within the physiologically normal range of temperature. In the present case also the Q_{10} decreases with increasing body weight at all the temperature ranges studied and it also decreases with increasing temperature.

As in respect of metabolism in relation to temperature in clams, salinity also has considerable influence on their metabolic activity. In *K. opima* in 100% sea water, the increase in oxygen-consumption is surface area dependent (b=0·66). The oxygen-consumption increases with decrease in salinity and in 75% sea water (b=0·60) and in 50% sea water (b=0·50) an intermediate condition is observed. In *M. meretrix* the oxygen-consumption shows an intermediate condition in all the salinities studied. However, in 100% and 50% sea water there is a slight tendency towards surface area dependence (b=0·72 in 100% and b=0·71 in 50% sea water). The slight high value of 'b' (0·72) in 100% sea water as compared with that at 30°C given earlier (b=0·66) may perhaps be on account of the difference in the experimental temperature which in the present case was around 29°C.

From the size metabolism curves presented in Figs. 7 and 8 it will be seen that the oxygen-consumption in clams increases with the same power of body weight at any given salinity throughout the weight range studied. Conversely the unit oxygen-consumption decreases with increasing body weight, this decrease being more marked in 50% sea water. Thus the unit oxygen-consumption in *K. opima* decreases from 0·81 to 0·32 in 50% sea water whereas the corresponding decrease in 75% and 100% sea water is from 0·64 to 0·31 and from 0·56 to 0·30 respectively between 0·5 and 4·0 gm clam. Considering 100% sea water as the habitat salinity, in which the clams show minimum activity, it will be seen that the curve for 75% and 50% sea water considerably deviates from the curve for the 100% sea water, which has the maximum slope. It is also evident from the curves that the displacement is more conspicuous in smaller clams than in larger ones, indicating that the former are more sensitive to salinity changes.

In *M. meretrix* also the unit oxygen-consumption decreases from 0·63 to 0·33 in 50% sea water whereas the corresponding decrease in 75% and 100% sea water is from 0·36 to 0·25 and 0·52 to 0·31 respectively between 0·5 and 4·0 gm clam. However, in this species the maximum slope (b=0·84) is obtained in 75% sea water instead of 100% sea water (b=0·72). This is rather a peculiar behaviour. Thus this species shows minimum activity in 75% sea water and not in 100% sea water as in *K. opima*. Therefore, unlike *K. opima* in which the oxygen-consumption increases with decrease in salinity in *M. meretrix* the oxygen-consumption decreases with decrease in the salinity from 100% to 75% sea water, in which the minimum activity is noticed. With further reduction in the salinity from 75% to 50% sea water, however, the oxygen-consumption increases. Considering the importance of ' b ' value it is likely that *M. meretrix* is more at home in 75% sea water than in 100% sea water and, therefore, could be considered as more adapted to low salinity conditions than *K. opima*. From the experiments conducted on the salinity tolerance in the two species, it has been found that *M. meretrix* is more tolerant to low salinity conditions than *K. opima*, and has, therefore, succeeded better in invading estuaries and backwaters and is often found quite far up the river. The metabolic response in this species, in relation to salinity, showing minimum activity in 75% sea water (salinity=25·5‰), also lends support to this idea. Presuming that 75% sea water as the natural requirement for *M. meretrix* (ideal habitat salinity) it will be seen that the oxygen-consumption increases with either increase or decrease in this salinity, perhaps on account of the osmotic stress either ways, to be discussed later. Considering 75% sea water as ideal habitat salinity, it will be observed that the curves for other two salinities considerably deviate from the one for 75% sea water, the displacement being more conspicuous in smaller clams than the larger ones, indicating their more sensitive nature to changes in the salinity, either above or below the ideal salinity.

Considerable amount of work has been done on the effects of osmotic conditions of the metabolic activities. It is well-known that the animals show an increase in metabolism when placed in stress media. *Carcinus maenas* shows an increase in oxygen-consumption with decrease in salinity (Schlieper 1929). Flemister & Flemister (1951) found lowest oxygen-consumption in sea water (378 mM Cl/L) isotonic with the crab blood in case of *Ocypoda albicans*, but more hypotonic than the field conditions (480 mM Cl/L). They found that the oxygen-consumption increased as the sea water varied from isotonicity, highest being in hypotonic media. More or less similar results were obtained by Schwabe (1933) in case of cray fish *Potamobius fluviatilis*. The observations made by the abovementioned authors suggest that the increase in oxygen-consumption has resulted from increased osmotic work. But Gross (1957) has shown that in *Uca* oxygen-consumption did not always increase with osmotic stress. Marshell *et al.* (1935) also found that there was 30% reduction in oxygen-consumption when measured in 50% sea water than in normal sea water (salinity=34‰). Potts (1954) also has shown that in *Eriocheir* only a very small fraction of increased oxygen-consumption represents osmotic work done. The results of Gross (1957), Marshell *et al.* (1935) and Potts (1954) are not in agreement with those of the earlier quoted authors.

The tendency for CO_2 to accumulate in lower salinities, resulting in increased respiratory rate has been suggested by Schlieper (1929). Anoher interpretation of increased oxygen-consumption with lowering of salinity was proposed by Schlieper (1935) on the idea that due to absorption of water in low salinity, the volume of tissue and surface is increased facilitating absorption and hence oxygen-consumption. Wikgren (1953) is of opinion that increase in oxygen-consumption is not due to osmotic regulation but either on account of swelling of tissues as suggested by Schlieper (1935) or by its influence on the endocrine balance. Violent attempts to escape from unfavourably low salinity, leading to extra muscular activity, resulting in increased oxygen-consumption has been suggested by Gross (1957) in the crab *Pachygrapsus.* Dehnel (1960) who studied metabolic response in *Hemigrapsus oregonensis* and *Hemigrapsus nudus* in relation to temperature and salinity, found results in the former species which could be considered as in accordance with Gross (1957) or Schlieper (1935) ; whereas in the other species the results were contradictory. Lofts (1956) compared respiratory rate of *Palaemonetes varians* from two different populations, one from low saline environment (salinity=1·3‰) and the other from high saline environment (salinity=23·5‰), and found minimal respiratory rate in water of salinity 26·00‰ for high salinity population, a condition which was isotonic with the animal, whereas the minimal rate in low salinity population was found in salinity 6·00‰, a condition somewhat hypertonic to the environment in which these animals were found. Rao (1958) who compared oxygen-consumption in marine and brackish water populations of *Metapenaeus monoceros,* found that prawns from marine environment showed minimum activity in 100% sea water (salinity=35·5‰) whereas the minimum metabolic activity in prawns from brackish water environment was exhibited in 50% sea water (salinity=16·75‰), their oxygen-consumption increasing in 100% sea water. In both the groups of prawns the oxygen-consumption increased with decrease in salinity below the habitat salinity, and in the brackish water population the increase was also effected as the salinity increased to 100% sea water. He suggested that these differences may be due to osmotic adaptation and operation of a metabolic homoeostatic mechanism in relation to osmotic regulation.

The results obtained in the present investigation on the metabolic response in clams, though it involves two different species from the same environment, could be favourably compared on the strength of metabolic response as those belonging to two groups of populations physiologically, one, *M. meretrix* as more adapted to low saline environment (25·5‰) and the other *K. opima* as adapted to marine environment (34·0‰). Therefore, the minimum activity in *M. meretrix* is found in salinity 25·5‰ and in *K. opima* in salinity 34·0‰. Hiscock (1953) states, 'In euryhaline marine species oxygen-consumption is at its lowest when the external medium is isotonic and rises as the later becomes hypo or hypertonic to the blood'. No data is available on the osmoregulation in these clams and, therefore, it is not possible to say whether isotonic condition is found in *M. meretrix* when exposed to 75% sea water and in *K. opima* in 100% sea water. It would be very interesting to study this aspect which might throw some light on the metabolic response in clams in relation to salinity. It is only suggested here that the differential metabolic response in clams to different saline media might be due to osmotic stress, though possibilities of increase in oxygen-consumption on account of absorption of water and subsequent swelling of the tissues, as suggested by Schlieper (1935) cannot be completely overruled in absence of any data on this aspect. In the experiments described earlier (Ranade & Kulkarni 1972) on the opening of the shell valves in relation to salinity, it has been shown that the opening of the valves in clams is progressively delayed as the salinity of the environment decreases. So in media hypotonic to blood, the closing of the shell valves relieves the animal from osmotic embarrassment. When the clams open after some time, depending on the strength of the solution, chloride ions are lost. These are perhaps replaced by active absorption from the environment as suggested by Krogh (1939). This process must require energy and hence the increase in the rate of oxygen-consumption with decrease in the salinity of the external medium.

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A Catalogue of the Birds in the Collection of the Bombay Natural History Society—14

Meropidæ and Coraciidæ

BY

HUMAYUN ABDULALI

[*Continued from Vol.* **69** (3) : 546]

This part deals with 302 specimens of 20 species and subspecies upto No. 762 in IND. HANDBOOK (**4** : 123) and No. 23692 of the Society's register. Mr. S. A. Hussain, Research Assistant, assisted with measurements.

744 **Merops leschenaulti leschenaulti** Vieillot (Java, *errore* Ceylon) Chestnutheaded Bee-eater **4** : 240

21 : 10 ♂♂ (3 juv.) 8 ♀♀ 3 o ?
1 Sawantwadi; 1 Kadra, Kanara ; 2 Coonoor Ghats, Nilgiris ; 2 Manalur, Palni Hills ; 1 Rajaputtee, Saran, Bihar ; 1 Kurseong Division ; 2 Goalpara, 1 Shillong, 2 Rema T.E., Sylhet, 1 N. Cachar, Assam ; 2 *Singhaling, Hkanati,* 1 *Manswa, W. Bank, Chindwin* ; 1 *Mogok, Ruby Mines* ; *1 *Thayetmyo* ; 1 *Sandoway Dt.* ; 1 *Ngewpharo, Prome Dt.* *missing.

The males and females, and northern and southern birds show no differences in size.

	Wing	Bill	Tail
16 ♂♀	104-110 av. 106·5	26-33 av. 31·5	76-85 av. 81·3
	(IH 104-111	from skull 35-40	76-84)

The tail is slightly forked with the central pair of feathers projecting into the gap, but not as long as the outermost. Of the three juvenile males, with incomplete breastbands, one with a short bill has green on the forehead while another older bird has green at the rear end of the chestnut cape.

As this bird does not appear to have been recorded from Bihar, I may mention that Mr. D. E. Reuben saw a Chestnutheaded Bee-eater in his compound at Patna, Bihar, on 7 March 1953 (pers. comm.).

745 **Merops leschenaulti andamanensis** (Marien) (Port Blair, South Andaman Island) Andaman Chestnutheaded Bee-eater

7 : 5 ♂♂ 2 ♀♀
3 Wrightmyo, 2 Bambooflats, 1 Port Blair, 1 South Andaman.

746 **Merops apiaster** Linnaeus ('Europa australi; oriente') European Bee-eater 4 : 233

27 : 8 ♂♂ 11 ♀♀ (2 juv.) 8 o ? (3 juv.)

1 *Amara*, 1 *Shushan Mounds*, 1 *Zinjan*, *Karim Tabriz*, (?) *Mesopotamia*; 1 *Fad*, 1 *Mishim*, 1 *Persian Gulf*; 5 *Shiraz*, 1 *Kain*, *Persia*; 1 *Randha Tanhat*, *Yemen*, 1 *Muscat*, *Arabia*; 4 Mastung, Baluchistan; 1 Quetta, 1 Peshawar, 4 Chitral; 2 Srinagar, 1 Kashmir.

	Wing	Bill	Tarsus	Tail
♂♂	145-157 av. 151·5	34-37 av. 36	12-14	108-118
	(IH 144-156	from skull 37-44	12-14	108-120)
♀♀	144-146, one 157 (?)	32-36 av. 35	11-12	100-112
	(IH 138-148	—	—	—)

14 in summer plumage between 14 February and 13 June.
8 in winter plumage between 30 May and 30 September.
5 juveniles 4 May to 14 October.

747 **Merops superciliosus persicus** Pallas (Shores of the Caspian Sea) Bluecheeked Bee-eater 4 : 239

40 : 14 ♂♂ (4 juv.) 8 ♀♀ (2 juv.) 18 o ? (7 juv.)

3 *Muscat*, 2 *Siyahad* (? Philby), *Arabia*; 1 *Amara*, 2 *Shaiba*, 2 *Nahr Umar*, *Basrah*; 1 *Mesopotamia*; 1 *Fao*, 3 *Bahm-i-Shur*, 1 *Boghan on Nihing*, *Persian Baluchistan*; 2 Harbud, about 55 m east of Panjgur, 2 Teghab, 107 m south of Kalat, 1 Shinzai, Patti, Baluchistan; 2 Hyderabad, Sind; 1 Bharatpur; 1 Hamavas Lake, Pali Dist., Jodhpur; 1 Bhuj, Kutch; 2 Bhavnagar, 1 Ajwa, Baroda; 1 Ghoti, 1 Dindori, Nasik; 7 Thana Dist.; 2 Kihim, Kolaba Dist.

This race is currently accepted as breeding from Palestine eastwards through Iraq to Baluchistan and north-western India, having been found nesting as far south as Bhavnagar in Gujarat arriving there in May. The young of the year (juveniles) are duller in colour and show more blue and less green on the underparts and on the rump. The central tail-feathers though projecting a few millimetres beyond the others are not attenuated as in the adults. Nine of the 18 birds obtained in India are in this plumage.

Among the adults there are differences in the intensity of colour but extra-limital specimens appear more green than those from India. Accepting one complete moult between November and January (Marien, *JBNHS* 49 : 158) the 12 birds in fresh (green) plumage are 4 in March, 5 April, 2 May, and 1 June *contra* 11 in worn (bluish) plumage 1 in April, 1 July, 4 August, 2 September, 1 each October, November, and December. Except for shorter tails, 90-140 av. 108 *contra* 130-150 av. 129, there is no difference in measurements. The small proportion of sexed birds does not suggest any difference in size between males and females, and all are measured together.

	Wing	Bill	Tarsus	Tail
Ad. ♂♀	130 (next 141)-157 av. 149	36-44 av. 38	11-12	90-150
	(146-160	35-44	11-12	135-148)
Imm. ♂♀	135-145 av. 140	35-41 av. 38	11-12	86-101 av. 94

Sp. No. 11160 ♂ Kalat, Baluchistan has the second outermost tail-feather blunt and not attenuated but projecting 15 mm beyond the others.

748 **Merops philippinus philippinus** Linnaeus (Philippine Islands) Bluetailed Bee-eater 4 : 237

30 : 16 ♂♂ 11 ♀♀ 3 o?

1 Simla Hills, 2 Jagadhri, Ambala ; 1 Mandi, Dhar State, C.I. ; 1 Thana Creek; Bombay, 1 Ratnagiri ; 2 Karwar ; 1 Karupadana, Travancore State, 1 Cumbum Valley, 2 Krishna Dt., 1 Vizagapatnam, A.P. ; 1 Cuttack, Orissa; 3 Baghowni, Tirhut ; 1 Kahanpur, Cawnpore, 2 Kumaon, Naini Tal ; 1 Dibrugarh, 2 Assam ; 1 Maymyo, 1 Bambooflats, 1 South Andamans ; 1 Camorta, 2 Trinkut, Central Nicobars ; 1 *Henzada, Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	121-136 av. 131	38-41 av. 38·5	10-12	120-146 av. 134
	(IH 133-139	from skull 45-48	11-13	130-141)
♀♀	127-133 av. 130	35-40 av. 37	10-12	115-141 av. 127
	(IH 126-131	from skull 43-46	—	115-136)

The juveniles, with no pinfeathers in the tail but otherwise almost fully grown, have paler rufous throats and the underparts more bluish than green. No. 11145 ♀ Baghowni, Tirhut is younger (bill 28 mm, wings and tail in moult) but approaches the adults in colour.

749 **Merops orientalis beludschicus** Neumann (Sarbaz, Persian Baluchistan) Sind Small Green Bee-eater 4 : 236

6 : 4 ♂♂ 1 ♀ 1 o? (juv.)

1 *Mand, Iraq* ; 2 *Mishun*, 2 *Charbar*, 1 *Baba Kallu, Persian Gulf.*

The four adult males with pins in the tail have pale blue underparts which, together with the general paleness all over, immediately separate them from all specimens from India and Pakistan, which show a fair amount of variation among themselves.

The single female (wing 95, bill 25), which lacks the tail pins and the black pectoral band, is varying shades of pale blue and white (reminiscent of a Verditer Flycatcher) with no green and very different from females of the nominate form. The juvenile is, to use Ticehurst's words, a washed-out edition of the adult.

The type locality Sarbac=Sarbaz (Vaurie) is only a hundred miles from Chah Bahar (Charbar) in Persian Baluchistan along the coast of Gulf of Oman, west of Indian (Pakistan) limits. Two birds from Gajar 2200′ and Korak 1900′, which are noted as 165 and 185 m respectively S.S.W. of Kalat, Baluchistan, are quite different, and though slightly paler can be included among the variations in the Indian birds. They are marked *beludschicus* by Ticehurst (?).

Ticehurst (1923, Birds of Sind, *Ibis* p. 29) refers to comparison of Sind birds, which he calls *beludschicus*, with topotypes (the type locality is not mentioned) and states ‘ they are paler blue on the throat, paler below and less bronzy on the nape than Southern Indian birds. This race extends to the lower Punjab and Jodhpur at all events.'

This was before publication of Vol. 4 of Stuart Baker's FAUNA (1927) and it is not known what specimens or literature were available to Ticehurst.

Specimens from Rawalpindi, Jullundur, Ambala, Bahawalpur, and Jodhpur can be unhesitatingly left with nominate *orientalis* as has been done below.

Having regard to the reports of later authors, e.g. Marien (*JBNHS* **49** : 162) and the material available, I cannot help feeling that a mistake has been made in accepting all birds from Baluchistan as *beludschicus* and then having difficulty in establishing that they are different from those from India. Though *beludschicus* may (?) extend towards Karachi along the coast, it does not occur all over Baluchistan and Sind and our westernmost birds, though perhaps slightly paler than those from peninsular India, are really much closer to the nominate race.

750 **Merops orientalis orientalis** Latham (India=Pondicherry) Indian Small Green Bee-eater **4** : 234

50 : 26 ♂♂ 18 ♀♀ 6 o?

1 Gajar, 165 m. SSW. of Kalat, 1 Korak 180 m. S. of Kalat, Baluchistan ; 1 Rawalpindi, 1 Nawashahr, Jullundur, 3 Ambala, Punjab ; 1 Bahawalpur ; 3 Delhi ; 1 Bhinmal, Jodhpur ; 3 Kutch, 1 Dalkhania, Amreli Dt., 1 Cambay City, 1 Gir Forest, 1 Bodeli, Baroda, Gujarat ; 1 Kolkaz, Melghat, Berar ; 1 Kolshet, Thana, 1 Kandivli, Salsette, 1 Bombay ; 2 Walwan, Poona ; 2 Satara ; 2 Ratnagiri ; 1 Nilambur, S. Malabar, 1 Gudalur, Nilgiris ; 1 Kuttani, 1 Jamestown, Kanyakumari ; 1 Kalai, Trichnopoly, 1 Chitteri Range, 1 Seshachalam Hills, 1 Cudappah, 1 Cumbum Valley, Kurnool Dt., A.P. ; 2 Antagarh, Bastar ; 1 Dholpur, Band, Orissa ; 1 Baghowni, 1 Tirhut, Bihar ; 1 Sarun, 1 Calcutta Market, Bengal ; 1 Meerut, 1 Bulandshahr, U.P. ; 2 Bankulwa Morang, Nepal, 1 Goalpara, Assam.

There is some variation in the amount of blue on the chin, the intensity of green both above and below, and the extent of the golden sheen on the head. These differences however cannot be segregated and must be accepted as variations within the same race. One ♀ No. 21448 [(wing 91 ; bill 25 ; tail 116) Ratnagiri, coastal Maharashtra] collected on 7 January shows an inordinate amount of blue both above and below, but does not resemble *beludschicus*.

	Wing	Bill	Tarsus	Tail
♂♂	89-97 av. 91·5	23-28 av. 25·8	8-10	105-140 av. 121
♀♀	89-98 av. 92·5	22-27 av. 25	8-10	92-127 av. 109

751 **Merops orientalis birmanus** Neumann (Myingyan, Irawaddy River, Burma) Burmese Small Bee-eater **4** : 236

3 : 1 ♂ 2 ♀♀

1 *Maymyo*, 1 *Sinde*, *Prome*, 1 *Kyagyun*, *Henzada*, *Burma*.

[245]

Wing	Bill	Tarsus	Tail
89, 95, 98	25, 25, 27	9-10	103, —, 120

The golden cap on the head is larger, extending on to the nape. The two females show very little of the black gorget across the front.

752 **Merops orientalis ceylonicus** Whistler (Kalawewa, Ceylon)
Ceylon Small Green Bee-eater

1 ♂ Hambentota, Ceylon

Wing 89 (IH 92-95) ; bill 26 ; tarsus 9 (IH 9-10) ; tail 80 without pins.

This is a poor specimen, but the chin and underparts show blue, the bill is heavy, and the golden sheen on the head extends on to the nape.

EL **Merops orientalis cyanophrys** Cabanis & Heine (Al Qunfidha, Asir, Arabia)

1 ♂ *Muscat, Muttrah*

Wing 92 ; bill 25 ; tarsus 9 ; tail 91.

This bird received from the Peabody Museum is marked *M. o. muskatensis* which is synonymized with *cyanophrys* by Vaurie, 1959, *Am. Mus. Novit.*, 1971, p. 8.)

753 **Nyctyornis athertoni athertoni** (Jardine & Selby) (Bangalore)
Bluebearded Bee-eater **4** : 242

21 : 12 ♂♂ 6 ♀♀ 3 o ?

2 Bhopalpatnam, Bastar ; 1 Pithabhata, 1 Gurguria, Simlipal Hills, Mayurbhanj, 1 Mahendragiri, Orissa ; 3 Dehra Dun, 3 Kumaon, 1 Terai, U.P. ; 1 Longview T.E., Darjeeling ; 2 Kurseong Div. ; 2 Goalpara, 2 Margherita, Assam ; 1 *North Shan States*, 1 *Prome Dt., Burma*.

The original description refers to the forehead and crown being verditer-blue, and the beard ' a fine caerulean or verditer-blue varying in intensity and lustre as exposed in different positions to the light.' The accompanying plate shows a greater amount of blue on the forehead than is visible in any specimen, and the ' beard ' lacks the dark blue feathers invariably present. The ' beard ' is also followed by a patch of chestnut absent in the specimens.

In the absence of any material from the type locality or southern India, a ♂ collected by Sálim Ali at Hunsur, Mysore State, on 9 December 1939, was borrowed from American Museum of Natural History. Together with the five from Bastar and Orissa, they can in series be easily separated from the others from the north and east, by the clear grass green (' sap green ' in original description) upperparts which are darker in the others. Some of the eastern birds are lighter above but all have their cheeks a slightly darker green than in peninsular birds. Eastern birds are also ' more richly coloured and more heavily striped on the nderparts ' (*a la* Koelz for *bartletti*).

5 (2 ♂♂ 1♀ 2 o ?) from Terai (1), Kumaon (2), and Dehra Dun (1) and Goalpara (1) have their green upperparts washed with blue, a character missing in southern birds, though Jardine & Selby refer to the type of unspecified origin having a few of the feathers (of the upperparts) being tipped with verditer-blue. The evidence available suggests that northern and eastern birds differ from those from the south, but an examination of a larger series is necessary to permit a decision. Hodgson (1836, *J. A. S B.* v, p. 361) has already described *Bucia nipalensis* from Nepal (obviously without knowledge of *athertoni*) while Koelz's *bartletti* (1954, *Contrib. Inst. Regional Exploration*, No. 1 : 25) from Keitum, Lushai Hills, may be available for the eastern birds.

Two specimens (♂ and ♀) Tama, Central Bhutan, collected by Sálim Ali in March 1967, but which have not yet been registered, are an outstandingly deeper green above and the blue on the forehead is more prominent than in the others.

	Wing	Bill	Tail
	From south of Brahmaputra		
5 ♂♂	133-141 av. 138·5	38-45 av. 43·6	130-139 av. 134·5
	Others from northern India		
♂♂	134, 135(3)	37, 40, 41, 42	131, 132(2), 133
♀♀	132(2), 135, 136	39(3), 41	125, 127, 130, 134
o ?	132, 136, 137	39, 40, 42	130(2), 131
	From Orissa & Bastar		
♂♂	136(2), 137	44(2), 45	128, 130, 132
♀♀	132, 138	40(2)	127, 130
♂ Mysore	144	43	134

IND. HANDBOOK (**4** : 112) refers to this species occurring in the Western Ghats complex from Khandesh southwards through Surat Dangs (?), Maharashtra, and southwards. Osmaston (*JBNHS* **38** : 805) saw it at Pachmari, Hoshangabad, C.P., while Sálim Ali heard it near Songadh, Navsari Dist., Gujarat (*JBNHS* **52** : 446). I have been unable to trace any records from anywhere else in Maharashtra, north of Karwar. Sp. No. 18819 collected by A.E. Jones at Dehra Dun on 8th February 1940 bears the following: 'Pair seen at Rajpur (Dehra Dun). Displaying before another like a roller (*Coracias*). Notes also reminiscent of roller.'

754 **Coracias garrulus semenowi** Loudon & Tschudi (Transcaspia)
Kashmir Roller **4** : 222

19 : 7 ♂♂ (3 juv.) 7 ♀♀ (1 juv.) 5 o ?

1 *Red Sea* ; 1 *Baghdad*, 1 *Hindiyeh Barrage*, 1 *Shustar Mounds*, 1 *Mesopotamia* ; 2 *Mishum, Persian Gulf* ; 1 Mastung, Baluchistan ; 1 Razmak, N. Waziristan, 1 Quetta, 2 Chitral ; 1 nr. Kapurwara, 54 m. from Srinagar, 1 Lolab Valley, 1 Kashmir ; 1 Chadva, Bhuj ; 1 Ajwa, Baroda ; 2 Malad, Bombay.

♂ No. 11016, Red Sea, an old skin dated May 1893, wing 193, tail 127, with underparts showing a tinge of greenish, may be of the nominate race. Among the others, unsexed No. 11013 Mesopotamia 23rd

April, 1917, is the specimen identified by Ticehurst in 'The Birds of Mesopotamia' (*JBNHS* **28**: 303) as *Coracias g. garrulus.* It differs from most of the others in having the throat and upper breast a deeper blue, a character shared with three others, a ♂ from Razmak, N. Waziristan, and two females from Kashmir.

It is curious that the 4 specimens from peninsular India are all young birds, 3 juveniles recognized by their paler upperparts and short outer tail-feathers and the fourth with a fully-grown tail but a brown wash on the breast. The sexes show no differences in size and the 15 adults are measured together :

	Wing	Bill	Tarsus	Tail
♂♀	189-213 av. 197	30-36 av. 33	20-26 av. 22	116-127 av. 124
	(180-210	30-35	25-26	122-135)

755 **Coracias benghalensis benghalensis** (Linnaeus) (Tulin, Purulia, West Bengal) Northern Roller 4: 224

31 : 17 ♂♂ (1 juv.) 11 ♀♀ 3 o?

Northern birds are slightly larger than those from the south, but in the specimens available the extra-limital and western birds have their upperparts paler than those from the east and also the south. Though part of the paleness may be due to wear, no dark specimen comes from west of the Punjab and Kutch. The few paler birds from further south (Satara and Santa Cruz, Bombay) may well be winter visitors.

A better series is necessary to take any definite decision, but I am for the moment listing the paler birds separately though under nominate *benghalensis.*

(a) *benghalensis* (darker)

14 : 10 ♂♂ 1 ♀ 3 o?

1 Bhagat State ; 2 Ambala, Punjab ; 1 Sanchi, Bhopal State ; 1 Bhanupratappur, Kanker, C.P. ; 2 Barkot, Bamra, Orissa ; 1 Baghownie, 1 Tirhut, 2 Hazaria, Patherghata, Bihar ; 1 Nawalpur, 1 Bankulwa Morang, Nepal ; 1 Rema T.E., S. Sylhet.

No 18995 from Bhanupratappur, Kanker, C.P., has deep blue behind the eye, which extends backwards forming a very distinctive and different border to the blue of the head.

(b) *subsp.*? extra-limital and western (paler)

17 : 7 ♂♂ (1* juv.) 10 ♀♀

1 *Nahr Umar, R. Tigris, Mesopotamia* ; 1 *Chahrbar, Persian Gulf* ; 2 Gajar (Mastkai) 165 m. SSW. of Kalat, Baluchistan; 1 Jajjah, Abbasian, Bahawalpur, Punjab ; 6* Kutch, 1 Gir Forest, 1 Patan, Mehsana Dt., 1 Bodeli, Baroda, 1 Golana, Cambay, Gujarat ; 1 Santa Cruz, Bombay, 1 Mehda, Satara, Maharashtra.

The juvenile from Kutch lacks all traces of blue on the upper breast and, though paler both above and below, resembles in this respect, two juveniles of *indica* (Cumbum Valley).

	Wing	Bill	Tarsus	Tail
(a) 14 ♂♀	175-196 av. 187	30-34 av. 32·2	21-25 av. 23·5	122-132 av. 127
(b) 17 ♂♀	176-192 av. 183	29-34 av. 31·5	21-25 av. 23·5	120-134 av. 125·7
	(IH 178-201	from skull 39-49	25-29	117-140)

756 **Coracias benghalensis indica** (Linnaeus) (Ceylon) Southern Roller **4**: 226

11 : 6 ♂♂ 3 ♀♀ (2 juv.*) 2 o?

1 Bombay, 2 Walwan, 1 Poona, Maharashtra ; 1 Karwar, 1 Cassimode, 1 Jamestown, Kanyakumari ; 1 Chitteri Range, Salem ; 2* Cumbum Valley, Kurnool ; 1 Induni (?)

	Wing	Bill	Tarsus	Tail
♂♀	175-184 av. 180·7	30-32 av. 31	20-24 av. 22	119-130 av. 125·5
	(IH 170-190	from skull 41-49	24-26	109-132)

The 42 specimens available from over a wide area covering the accepted range of the two subspecies nominate *benghalensis* and *indica* cannot be separated on the basis of the colour characters generally accepted, namely : (1) intensity of colour of nuchal collar, and (2) darker, more greenish upperparts of *indica*. Southern birds are slightly smaller, but those from Nepal and Bihar do not differ in colour from the southernmost specimens.

757 **Coracias benghalensis affinis** Horsfield (Assam) Burmese Roller **4**: 226

12 : 4 ♂♂ 5 ♀♀ 3 o?

1 Bankulwa, Morang, Nepal ; 1 Kurseong Div., Bengal ; 2 Dibrugarh, 1 Roop chena, 2 N. Cachar, 1 Golaghat, Assam ; 1 *Kamaing*, 1 *Maymyo*, 2 *Prome*, *Burma*

	Wing	Bill	Tarsus	Tail
♂♀	180-197 av. 189	32-37 av. 35	24-27 av. 25·5	117-135 av. 126·5
	(184-204	30-36	26-28	118-137)

These birds are darker than *benghalensis*, both above and below, the underwing coverts being deep blue, matching the colour of the wing quills. All except No. 11062, a female from Golaghat, Assam, show a few pale blue feathers on the underwing. ♂ No. 11034, Bankulwa, Morang, Nepal, collected by N. A. Baptista on 16th March 1921, agrees with *affinis* except for a few additional pale blue feathers under the wing and the fact that the feathers on the throat show pale shaft streaks as in *benghalensis*. Another ♂ No. 11033 collected at the same place on 5th March 1921 agrees entirely with *benghalensis* with which it is listed suggesting that the area of intergradation is much further east than 85°E. suggested in IND. HANDBOOK (**4**: 119).

One unregistered female from Mangdechu, C. Bhutan, has the streaks on the chin brighter than in the others.

758 **Eurystomus orientalis cyanicollis** Vieillot (Chandernagor, Bengal) Himalayan Broadbilled Roller 4 : 228

10 : 5 ♂♂ (1 juv.) 2 ♀♀ 3 o ?

1 Almora, 2 Kumaon, Naini Tal, U.P. ; 1 Balasun, Darjeeling ; 1 Golaghat, 2 Margherita, 1 Bagho Bahar, Cachar, 2 Rema T.E., Sylhet, Assam

5 specimens, including the juvenile, do not have the clear pale blue patch on the primaries which appears to be an adult character.

	Wing	Bill	Tarsus	Tail
♂♀	178-206 av. 194	25-32 av. 27·5	17-19 av. 18	95-109 av. 101·5
	(IH 178-198	from skull 27-35	20(1)	90-102)

The juvenile is duskier all over, and has a black upper mandible.

759 **Eurystomus orientalis laetior** Sharpe (Forests of Malabar, the Nilgiris and Ceylon, restricted to Eridge, Travancore) Kerala Broadbilled Roller 4 : 228

3 ♂♂

2 Thattakad, North Travancore, 1 Tenmalai, Central Travancore

Wing	Bill	Tarsus	Tail
191, 199, 200	27, 28(2)	15(2), 16	101, 105, 108
(IH 194-205	from skull 33-36	19-20	99-106)

760 **Eurystomus orientalis irisi** Deraniyagala (Maha-oya, Ceylon) Ceylon Broadbilled Roller

nil.

762 **Eurystomus orientalis gigas** Stresemann (Rutland Island, Andaman Islands) Andaman Broadbilled Roller 4 : 231

8 : 6 ♂♂ 2 ♀♀

3 Chirria Tapoo, 2 Wrightmyo, 1 Port Blair, South Andamans ; 2 South/Middle Andamans

	Wing	Bill	Tarsus	Tail
♂♀	190-202 av. 195·8	29-33 av. 31	18-19	102-112 av. 107
	(184-205	27-30	*c.* 21	106-112)

762*a* **Eurystomus orientalis** subsp.

1 ♀ Narcondam Island

(See Ripley's comments *JBNHS* **68** : 406)

Wing 193 ; bill 30 ; tarsus 18 ; tail 91.

(*to be continued*)

The Food-plants of Indian Rhopalocera

BY

D. G. SEVASTOPULO

Some years ago I published a series of four papers in this *Journal* on the Food-plants of Indian Heterocera (1940, Vol. **41**, Bombyces ; 1941, Vol. **42**, Agaristidae and Noctuidae ; 1948, Vol. **47**, Geometridae and Pyralidae ; 1949, Vol. **48**, Supplementary Lists). The present paper on the food-plants of the butterflies, follows the same pattern, except that I have added the botanical family after the name of the plants.

The various books consulted are as under :—

Bingham — FAUNA OF BRITISH INDIA, Vols. 1 & 2.
Talbot — FAUNA OF BRITISH INDIA, 2nd edit., Vols. 1 & 2.
Moore — LEPIDOPTERA OF CEYLON, Vol. 1.
Seitz — INDO-AUSTRALIAN RHOPALOCERA, Vol. 9.
Peile — A GUIDE TO COLLECTING BUTTERFLIES OF INDIA.
Bell — Common Butterflies of the Plains of India (Part xxxii et seq., *J. Bombay. nat. Hist. Soc.* xxx et seq.).
Common — Australian Butterflies.

I regret that I have been unable to consult the earlier parts of Bell's paper, neither Davidson & Aitkens' 'Notes on the Larvae and Pupae of some of the Butterflies of the Bombay Presidency' (1890, *J. Bombay nat. Hist. Soc.* **5**) nor Davidson, Bell & Aitkens'. 'The Butterflies of the North Kanara District' (1896/7, *J. Bombay nat. Hist. Soc.* **10** & **11**) but these are quoted extensively in both editions of the FAUNA OF BRITISH INDIA.

It must be emphasised that the term ' India ' is here used in the zoo, geographical sense, and not the political, and includes India, Pakistan, Bangladesh, Burma and Ceylon.

PAPILIONIDAE

TROIDES Hbn.—All recorded food-plants belong to the Aristolochiaceae.

T. helena L.—*Aristolochia indica*, *Bragantia wallichii* (Aristolochiaceae) (Peile, Talbot), *Aristolochia* (Bingham, Moore, Seitz).

POLYDORUS Swains.—Although usually referred to as *Aristolochia* Swallowtails, one species, *P. alcinous* Klug is reported to feed on *Cocculus thunbergi* (Menispermaceae) in Japan, and another, see below, on *Nepenthes* (Nepenthaceae).

P. jophon Gray—*Bragantia wallichii* (Aristolochiaceae) (Talbot).

P. hector L.—*Aristolochia indica* (Peile, Seitz, Talbot), *Bragantia wallichii, Aristolochia* sp. (Moore, mihi) (All Aristolochiaceae).

P. aristolochiae F.—*Aristolochia indica* (Peile, Bingham), *Bragantia wallichii* (Talbot), *Aristolochia* sp. (Moore, mihi), *Aristolochia indica, A. bracteata* (Seitz) (All Aristolochiaceae). Seitz adds ' Also on Piperaceae '.

P. philoxenus Gray—*Nepenthes* (Nepenthaceae) (Talbot, Seitz).

P. dasarada Moore—*Aristolochia* (Aristolochiaceae) (Talbot).

CHILASA Moore

C. agestor Gray—*Machilus odoratissima* (Lauraceae) (Peile, Bingham, Talbot, Seitz). Seitz adds ' possibly other Laurineae '.

C. clytia L.—*Tetranthera apetala, Alseodaphne semicarpifolia* (Bingham, mihi), *Tetranthera* (Moore), *Alseodaphne, Tetranthera, Cinnamomum,* etc. (Seitz), Lauraceae (Talbot). All Lauraceae.

PAPILIO L.

P. polymnestor Cr.—*Citrus grandis* (Peile), *Citrus, Atalantia* (Bingham), *Citrus decumana, Atalantia, Paramigyna monophylla* (Talbot), *Citrus decumana* (Moore), *Citrus* spp. (mihi), *Citrus, Atalantia, Paramigyna* etc. (Seitz). All Rutaceae. Also *Garcinia xanthochymus* (Bingham), *Garcinia* (Talbot) (Guttiferae).

P. memnon L.—*Citrus* (Rutaceae) (Talbot, Seitz).

P. rhetenor Westw.—*Citrus* spp. and other Rutaceae (mihi).

P. protenor Cr.—*Zanthoxylum alatum* (Bingham), *Zanthophyllum* (Talbot, Seitz). (Rutaceae).

P. bianor Cr.—Aurantiaceae (Seitz) (Now included in Rutaceae).

P. polyctor Bsd.—*Zanthoxylum alatum* (Talbot, Seitz), *Citrus* spp., other Rutaceae (mihi). All Rutaceae.

P. paris L.—*Citrus* spp. and other Rutaceae (mihi), *Evodia roxburghiana* (Rutaceae) (Seitz).

P. arcturus Westw.—Various Rutaceae (mihi).

P. crino F.—*Chloroxylon swietenia* (Meliaceae) (Talbot, Moore), *Chloroxylon* (Seitz).

P. buddha Westw.—*Zanthoxylum rhetsa* (Rutaceae) (Talbot, Seitz).

P. dravidarum Wd-Msn.—*Glycosmis pentaphylla* (Rutaceae) (Bingham, Talbot, Seitz).

P. helenus L.—*Zanthoxylum rhetsa* (Bingham), *Citrus* spp. and other Rutaceae (mihi), *Citrus, Zanthoxylum* (Seitz). All Rutaceae.

P. fuscus Goeze—*Citrus* (Rutaceae) (Seitz). In Australia on *Citrus, Microcitrus australasica, Fagara brachyacanthum, Halfordia scleroxyla, Morinda citrifolia* (Rutaceae) (Common).

P. polytes L.—*Citrus sinensis, C. aurantifolia* (Peile), *Citrus* spp. (Bingham), *Citrus, Murraya, Triphasia, Glycosmis, Zanthoxylum* (Talbot), *Citrus* spp., *Aegle marmelos* (mihi), *Citrus, Murraya, Triphasia, Zanthoxylum* (Seitz). All Rutaceae.

P. liomedon Moore—*Acronychia laurifolia* [Bingham (as *demoleon* Cr.), Talbot], *Acronychia laurifolia, Evodia roxburghiana* (Seitz). All Rutaceae.

P. demoleon Cr.—*Citrus* (Rutaceae) (Seitz).

P. demoleus L.—*Citrus sinensis, C. grandis, C. aurantifolia, Aegle marmelos* (Peile), *Aegle, Citrus* spp. (Bingham, mihi), Rutaceae spp. (Talbot), *Glycosmis, Murraya, Citrus, Ruta angustifolia*, etc. (Seitz). All Rutaceae. Also *Zizyphus* (Bingham), *Zizyphus jujuba* (Peile) (Rhamnaceae). In Australia on *Citrus* (Rutaceae), *Psoralea tenax, P. patens* (Papilionaceae) (Common).

P. alexanor Esp.—*Seseli dioicum, S. montanum, Ptychotis heterophylla* and other Umbelliferae (Talbot).

P. machaon L.—*Ammi majus, A. visnaga, Ducrosia anethifolia, Foeniculum vulgare, Conium maculatum* (Peile), *Foeniculum vulgare, Conium maculatum* (Bingham), *Daucus* (Talbot), *Daucus, Foeniculum* (Seitz). All Umbelliferae. Also *Ruta tuberculata* (Rutaceae) (Peile).

P. xuthus L.—*Aegle sepiaria, Citrus nobilis* (Rutaceae) (Talbot). In Japan.

GRAPHIUM Scop.

G. eurous Leech—*Machilus odoratissimus* (Lauraceae) (Talbot, Seitz).

G. nomius Esp.—*Polyalthia longifolia, Saccopetalum tomentosum* (Anonaceae) (Seitz).

G. aristeus Cr.—*Mitrephora froggattii* (Anonaceae) (Common). In Australia.

G. antiphates Cr.—*Unona lawii* (Anonaceae) (Bingham, Talbot, Seitz).

G. cloanthus Westw.—*Machilus odoratissimus* (Lauraceae) (Talbot, Seitz).

G. sarpedon L.—*Machilus odoratissimus, Cinnamomum, Alseodaphne. Litsaea, Camphora officinalis* and other Lauraceae (Talbot), *Machilus odoratissimus, Geijera salicifolia, Litsaea, Alseodaphne, Camphora officinalis* (Seitz). All Lauraceae. And in Australia on *Geijera salicifolia, Daphnandra aromatica, Tristania luarina, Cryptocarya, Planchonella laurifolia* (Laurineae), *Macaranga* (Euphorbiaceae), eggs on Avocado [*Persea americana* (Lauraceae) (Common)].

G. doson Feld.—*Cinnamomum* (Lauraceae), *Polyalthia* (Anonaceae) (Talbot, Seitz), *Polyalthia longifolia* (Anonaceae), *Michelia champaca* (Magnoliaceae) (mihi).

G. eurypylus L.—Anonaceae (Seitz). In Australia on *Anona, Diploglottis australis, Rauwenhoffia leichhardtii, Mitrephora froggattii* (Anonaceae) (Common).

G. agamemnon L.—*Anona squamosa* (Peile), *Anona, Saccopetalum, Gualteria, Polyalthia* (Talbot, Seitz), *Anona* (Moore). All Anonaceae, Also *Michelia* (Magnoliaceae) (Seitz), Magnoliaceae (Moore), *Cinnamomum* (Lauraceae) (Moore). In Australia on *Anona, Mitrephora froggattii* (Anonaceae) (Common).

LAMPROPTERA Gray

L. meges Zink.—*Illigera burmanica* (Combretaceae) (Bingham).

TEINOPALPUS Hope

T. imperialis Hope—*Daphne nipalensis* (Thymeleaceae) (Bingham, Talbot, Seitz).

HYPERMNESTRA Men.

H. helios Nick.—*Zygophyllum turcomanicum* (Zygophyllaceae) (Talbot).

PIERIDAE

LEPTOSIA Hbn.

L. nina F.—*Capparis heyneana, Crataeva religiosa* (Capparidaceae) (Peile, Talbot), Capers (Capparidaceae) (Bingham).

APORIA Hbn.—Larvae on Prunaceae, Rubiaceae and Berberidaceae (Talbot).

A. **leucodice** Evers.—*Berberis lycium* (Berberidaceae) (Talbot, Seitz).

A. **agathon** Gray—*Berberis nepalensis* (Berberidaceae) (Bingham, Talbot, Seitz).

DELIAS Hbn.—Larvae on *Loranthus* (Loranthaceae) (Talbot, Seitz).

D. **eucharis** Drury—*Loranthus* (Loranthaceae) (Peile, Bingham, Moore, mihi), *Loranthus longiflorus, L. elasticus, L. scurrula* (Talbot). Seitz says polyphagous, but also mentions *Hibiscus chinensis* (Malvaceae).

D. **aglaia** L.—*Nauclea rotundifolia* (Rubiaceae) (Bingham, Talbot, Seitz). Talbot adds ' It is much more likely that the larvae feed on a *Loranthus* growing on the tree mentioned '.

D. **belladonna** F.—*Loranthus* (Loranthaceae) (Seitz).

D. **hyparete** L.—*Averrhoa bilimbi* (Geraniaceae) (Seitz). I think that Talbot's remark under *aglaia* might well apply here also.

CEPORA Bilb.—Capparidaceae (Talbot, Seitz).

C. **nerissa** F.—*Capparis aphylla, C. sepiaria, C. heyneana, C. horrida* (Capparidaceae) (Talbot), *Capparis* (Bingham, Moore, mihi).

C. **nadina** Luc.—*Capparis heyneana, C. moonii, C. roxburghii* (Capparidaceae) (Talbot), *Capparis* (Bingham).

PRIONERIS Wall.—*Capparis* (Capparidaceae) (Talbot, Seitz).

P. **sita** Feld.—Capers (Talbot), *Capparis* (Bingham), *Capparis tenera* (Seitz). All Capparidaceae.

ANAPHEIS Hbn.—Capparidaceae (Seitz).

A. **aurota** F.—*Capparis pyrifolia, C. aphylla* (Peile), *Capparis pyrifolia* (Bingham), *Capparis aphylla, C. sepiaria, C. heyneana, Cadaba indica, Maerua arenaria* (Talbot), *Capparis horrida* (mihi), *Capparis* (Seitz). All Capparidaceae.

APPIAS Hbn.—

A. **libythea** F.—*Capparis horrida* (Bingham), *Crataeva religiosa, Capparis sepiaria* (Talbot), *Crataeva, Capparis* (Seitz). All Capparidaceae.

A. **lyncida** Cr.—*Crataeva religiosa* (Peile, Talbot, Moore, Seitz) (Capparidaceae). Seitz also mentions *Gymnosporia* (Celastraceae) and 'cotton tree', presumably *Bombax* sp. (Bombacaceae). Capers (Bingham).

A. **albina** Bsd.—*Hemicyclia venusta* (Euphorbiaceae) (Seitz).

A. **wardi** Moore—*Capparis heyneana* (Capparidaceae) (Talbot, Seitz).

PIERIS Schrank

P. **callidice** Hbn.—No Indian records, in Europe on alpine Cruciferae.

P. **napi** L.—Cruciferae (Talbot), in Europe on Cruciferae and Resedaceae.

P. **brassicae** L.—Cruciferae (Talbot), in Europe on Cruciferae, particularly *Brassica*, and *Tropaeolum* (Tropaeolaceae).

P. **rapae** L.—No Indian record, in Europe on Cruciferae, particularly *Brassica*, and *Tropaeolum* (Tropaeolaceae). Similar Australian records (Common).

PONTIA F.

P. **daplidice** L.—*Reseda* (Resedaceae), *Turritis*, *Sisymbrium*, *Sinapis*, *Alyssum* (Cruciferae) (Talbot).

EUCHLOE Hbn.

E. **ausonia** Hbn.—Cruciferae (Talbot).

IXIAS Hbn.—*Capparis* (Capparidaceae) (Seitz).

I. **marianne** Cr.—*Capparis sepiaria*, *C. divaricata*, *C. aphylla*, *C. grandis* (Capparidaceae) (Talbot).

I. **pyrene** L.—*Capparis sepiaria* (Capparidaceae) (Talbot).

COLOTIS Hbn.

C. **calais** Cr.—*Salvadora persica*, *S. oleoides*, *Azima tetracantha* (Salvadoraceae) (Talbot), *Salvadora persica* (Peile).

C. **phisadia** Godt.—*Salvadora persica* (Salvadoraceae) (Peile, Bingham, Talbot).

C. **vestalis** Btlr.—*Salvadora persica* (Salvadoraceae) (Peile).

C. **fausta** Oliv.—*Capparis spinosa* (Peile), *Maerua arenaria* (Talbot). Both Capparidaceae.

C. **etrida** Bsd.—*Cadaba indica* (Capparidaceae) (Talbot).

C. **eucharis** F.—*Cadaba indica* (Capparidaceae) (Talbot, Seitz).

C. danae F.—*Cadaba indica*, *Capparis sepiaria*, *C. divaricata*, *Maerua arenaria* (Capparidaceae) (Talbot).

HEBOMOIA Hbn.—*Capparis* (Capparidaceae) (Seitz).

H. glaucippe L.—*Crataeva religiosa*, *Capparis moonii* (Peile, Talbot), *Capparis* (Moore), *Capparis* spp., *Crataeva* (Seitz). All Capparidaceae.

VALERIA Horse.—Capparidaceae (Talbot, Seitz).

V. ceylanica Feld.—*Capparis heyneana* (Bingham, Seitz) (Capparidaceae).

V. valeria Cr.—*Capparis heyneana* (Talbot, Seitz), *Capparis* (mihi) (Capparidaceae).

CATOPSILIA Hbn.—*Cassia* (Caesalpinaceae) (Seitz).

C. crocale Cr.—*Cassia siamea* (Peile), *Cassia* (Seitz, mihi), *Cassia fistula* (Moore), *Cassia*, *Bauhinia racemosa* (Talbot). All Caesalpinaceae. Also *Butea frondosa* (Papilionaceae) (Talbot).

C. pomona F.—*Cassia fistula* (Peile, Talbot), *C. fistula*, *C. siamea* (mihi). In Australia *Cassia fistula*, *C. australis* (Common). All Caesalpinaceae.

C. scylla L.—In Australia *Cassia glauca*, *C. s. etesia* (Caesalpinaceae), (Common).

C. pyranthe L.—*Cassia tora*, *C. auriculata* (Peile, Talbot), *Cassia occidentalis* (Bingham), *Cassia* (Seitz). In Australia *Cassia* (Common). (Caesalpinaceae).

C. florella F.—Leguminosae (Moore). In East Africa *Cassia* spp. (Caesalpinaceae).

GONEPTERYX Leach

G. rhamni L.—*Rhamnus* (Rhamnaceae), *Vaccinium* (Ericaceae) (Talbot). In Europe recorded from *Rhamnus* spp. only.

EUREMA Hbn.

E. brigitta Cr.—*Cassia kleinii* (Caesalpinaceae) (Talbot). In East Africa on *Cassia* (Caesalpinaceae), *Hypericum* (Hypericaceae), *Acacia*, *Albizzia* (Mimosaceae).

E. blanda Bsd.—*Wagatea spicata* (Caesalpinaceae) (Peile, Bingham, Seitz), *W. spicata*, *Cassia* spp., *Delonix regia* (Caesalpinaceae) (Talbot), *Cassia* spp. (mihi).

E. hecabe L.—*Sesbania aculeata* (Papilionaceae) (Peile, Bingham), *Cassia tora* (Caesalpinaceae) (Bingham), *Cassia, Wagatea, Caesalpinia* (Caesalpinaceae), *Acacia, Albizzia, Pithecolobium dulce* (Mimosaceae), *Sesbania* (Papilionaceae) (Talbot), Leguminosae, *Pithecolobium dulce* (Mimosaceae) (Moore), *Cassia* (Seitz, mihi). In Australia on *Breynia oblongifolia, B. nivosa, B. cernua, Phyllanthus tenellus* (Euphorbiaceae), *Albizzia lebbek, Leucaena glauca* (Mimosaceae), *Sesbania aculeata, Indigofera* (Papilionaceae), *Cassia surattensis* (Caesalpinaceae) (Common). In East Africa on *Cassia* (Caesalpinaceae), *Hypericum* (Hypericaceae), *Albizzia, Entada abyssinica, Parkia filicoides* (Mimosaceae), *Aeschynomene, Lespedeza, Sesbania* (Papilionaceae).

COLIAS F.

C. erate Esp.—*Parochetus communis* (Papilionaceae) (Peile), *Trifolium* (Bingham) (Papilionaceae).

DANAIDAE

IDEA F.

I. malabarica Moore—*Aganosoma cymosa* (Apocynaceae) (Talbot, Seitz).

I. jasonia Westw.—A climber allied to the Genus *Hoya* (Asclepiadaceae) (Seitz).

DANAUS Klug

D. chrysippus L.—*Calotropis procera, C. gigantea* (Peile), *Calotropis gigantea* and other Asclepiads (Bingham), *Asclepias curassavica, Calotropis* (Talbot), *Calotropis gigantea, Asclepias curassavica* (Moore), *Calotropis procera* (mihi). In Australia *Asclepias fruticosa, A. curassavica, Pentatropis atropurpurea, P. quinquepartita, Marsdenia leichhardtiana* (Common). In East Africa on *Asclepias, Calotropis, Caralluma, Ceropegia, Cynanchum, Gomphocarpus, Huernia, Kanaria, Pergularia, Periploca, Schizoglossum, Secamone, Stapelia.* All Asclepiadaceae.

D. genutia Cr.—*Ceropegia* (Peile, Talbot), *Raphis pulchellum, R. lemma, Passularia, Ceropegia intermedia* (Bingham). All Asclepiadaceae.

D. affinis F.—In Australia *Cynanchum carnosum* (Asclepiadaceae) (Common).

D. limniace Cr.—*Calotropis, Asclepias, Hoya* (Bingham, Seitz), *Dregea volubilis, Hoya, Calotropis* (Talbot), *Asclepias* (Moore). In East Africa on *Daemia, Hoya, Pergularia.* All Asclepiadaceae.

D. hamata MacLeay—*Vallaris dichotoma* (Apocynaceae) (Bingham' Talbot). In Australia on *Marsdenia*, *Parsonsia* (Asclepiadaceae) (Common).

D. aglea Stoll.—*Tylophora carnosa*, *T. tenuis* (Peile), *Tylophora carnosa* (Bingham), *Tylophora carnosa*, *T. tenuis*, *Cryptolepis buchanani* (Talbot), *Cryptolepis*, etc. (Moore), Asclepiadaceae (Seitz). All Asclepiadaceae.

D. sita Koll.—*Marsdenia roylei* (Asclepiadaceae) (Bingham, Talbot).

EUPLOEA F.

E. core Cr.—*Nerium oleander* (Apocynaceae) (Peile), *Nerium oleander* (Apocynaceae), *Cryptolepis paucifolia* (Asclepiadaceae), *Ficus indica*, *F. glomerata* (Moraceae) (Bingham), *Nerium odorum* (Apocynaceae), *Ficus religiosa* (Moraceae) (mihi), *Streblus asper*, *Ficus bengalensis*, *F. religiosa*, *F. glomerata* (Moraceae), *Nerium odorum*, *N. oleander*, *Ichnocarpus frutescens* (Apocynaceae), *Hemidesmus indicus* (Asclepiadaceae) (Talbot), three species of *Ficus* and three of Apocynaceae (Seitz). In Australia on Oleander, *Mandevillea*, *Trachelospermum* (Apocynaceae), *Stephanotis*, *Hoya australis*, *Marsdenia leichhardtiana* (Asclepiadaceae), *Ficus* (Moraceae) (Common).

E. sylvester F.—*Ichnocarpus frutescens* (Apocynaceae) (Talbot, Seitz). In Australia on *Ficus glomerata* (Moraceae) (Common).

E. midamus L.—*Strophanthus divergens* (Apocynaceae) (Talbot, Seitz). Seitz adds ' also occasionally found on imported oleander '.

E. klugii Hors.—*Ficus hispida* (Moraceae) (Talbot), *Streblus asper*, *Ficus* (Moraceae) (Seitz).

SATYRIDAE

On Monocotyledons such as Graminaceae and Palmaceae (Talbot).

MYCALESIS Hbn.—Grasses (Gramineae) (Seitz).

M. anapita Moore—Certain rare grasses (Gramineae) (Talbot, Seitz).

M. perseus F.—Grasses (Gramineae) (Seitz, mihi).

M. mineus L.—Grasses (Gramineae) (Talbot, Seitz).

M. visala Moore—Grasses (Gramineae) (Talbot, Seitz, mihi).

M. patnia Moore—Grasses, *Oryza* (Talbot), *Oryza* (Seitz). All Gramineae.

LETHE Hbn.—On bamboo or grass (Gramineae) (Seitz, Talbot).

L. sidonis Hew.—Grasses (Gramineae) (mihi), *Arundinaria falcata* (Gramineae) (Talbot, Seitz).

L. europa F.—Bamboo (Gramineae) (Talbot).

L. rohria F.—Grasses (Gramineae) (Bingham, mihi).

L. drypetis Hew.—*Bambusa arundinaceae* (Peile, Talbot), *Bambusa* (Bingham) (Gramineae).

L. insana Koll.—*Arundinaria falcata* (Gramineae) (Seitz).

L. verma Koll.—Grasses (Gramineae) (mihi).

L. yama Moore—Bamboo (Gramineae) (Talbot, Seitz).

PARARGE Hbn.

P. schakra Koll.—Grasses (Gramineae) (Talbot).

AULOCERA Btlr.

A. swaha Koll.—Grasses (Gramineae) (Bingham, Talbot), Wild Blue Iris (Iridaceae) (Bingham). The latter appears doubtful.

EREBIA Dalm.—Grasses (Gramineae) (Talbot).

E. nirmala Moore—Grasses (Gramineae) (Talbot).

YPTHIMA Hbn.

Y. ceylonica Hew.—Grasses (Gramineae) (Talbot, mihi).

Y. asterope Klug—In East Africa on grasses (Gramineae).

Y. sakra Moore—Grasses (Gramineae) (mihi).

ORSOTRIOENA Wllgrn.

O. medus F.—*Oryza sativa* (Bingham), Grasses (Talbot, Seitz). In Australia on Grasses (Common). All Gramineae.

MELANITIS F.

M. leda L.—*Oryza*, Grasses (Peile, Talbot), Grasses (mihi), Gramineae (Moore). In Australia on *Imperata*, grasses and *Saccharum* (Common). In East Africa on *Bambusa*, *Digitaria*, *Panicum repens*, *Pennisetum purpureum*, *Zea mays*, Grasses generally. All Gramineae.

M. phedima Stoll.—Grasses (Gramineae) (Talbot).

M. zitenius Herbst.—Bamboo (Gramineae) (Talbot).

ELYMNIAS Hbn.—Palms (Palmaceae) (Seitz, Talbot).

E. **hypermnestra** L.—Various Palms, *Phoenix*, *Cocos nucifera*, *Areca*, *Calamus* (Peile), Palms (Talbot, mihi), Palmaceae (Moore). All Palmaceae.

E. **panthera** F.—Palms (Palmaceae) (Seitz).

AMATHUSIIDAE

FAUNIS Hbn.

F. **eumeus** Drury—Probably on grass and dwarf bamboo (Gramineae) (Seitz).

AMATHUSIA F.

A. **phidippus** L.—*Cocos nucifera* (Bingham), *C. nucifera*, *Borassus flabellifer*, *Elaeis guineensis* (Seitz). All Palmaceae, the latter two species introduced from Africa.

DISCOPHORA Bsd.—Palmaceae, *Saccharum*, Bamboo (Gramineae) (Seitz).

D. **sondaica** Bsd.—Bamboo (Talbot, Seitz). (Gramineae).

D. **lepida** Moore—Bamboo (Talbot), Bamboo, *Dendrocalamus* and other Gramineae (Seitz).

ACRAEIDAE

ACRAEA Hbn.

A. **issoria** Hbn.—*Debregeasia bicolor* (Peile), *D. bicolor*, *Boehmeria salicifolia* (Talbot), *Boehmeria salicifolia* (Seitz). Both Urticaceae. Seitz adds ' and all sorts of other weeds '.

A. **violae** F.—*Modecca palmata* (Passifloraceae) and cultivated kinds (Peile), *Modecca palmata* (Bingham, Talbot, Seitz), Cucurbitaceae (Moore).

N.B.—The preceding families have been arranged in the order adopted by Talbot in the FAUNA OF BRITISH INDIA, 2nd edition. The succeeding families are arranged according to Seitz' INDO-AUSTRALIAN RHOPALOCERA.

NYMPHALIDAE

Biblinidi

ERGOLIS Bsd.—On *Ricinus communis* and *Tragia* (Euphorbiaceae).

E. ariadne L.—*Tragia involucrata* (Peile), *T. involucrata*, *T. cannabina* (Bingham, Seitz). All Euphorbiaceae.

E. merione Cr.—*Ricinus communis* (Euphorbiaceae) (mihi).

BYBLIA Hbn.—*Tragia cannabina* (Euphorbiaceae) (Seitz).

B. ilithyia Drury—*Tragia cannabina* (Euphorbiaceae) (Seitz, by inference). In East Africa on *Tragia*, *Daleschampia* (Euphorbiaceae).

Pseudergolidi

PSEUDERGOLIS Feld.—*Debregeasia bicolor* (Urticaceae) (Seitz).

P. wedah Koll.—*Debregeasia bicolor* (Urticaceae) (Bingham).

Issorodidi

CUPHA Hbn.—*Flacourtia* (Flacourtiaceae) (Seitz).

C. erymanthis Drury—*Flacourtia* (Flacourtiaceae) (Bingham), *Glochidion eriocarpum* (Euphorbiaceae) (Seitz).

ATELLA Dbl.—*Ixora* (Rubiaceae) (Seitz).

A. phalanta Drury—*Flacourtia* (Flacourtiaceae) (Bingham, Moore), *Salix* (Salicaceae) (Moore). In East Africa on *Gymnosporia*, *Maytenus ovatus* (Celastraceae), *Aberia*, *Dovyalis*, *Flacourtia* (Flacourtiaceae), *Populus*, *Salix* (Salicaceae).

A. alcippe Cr.—*Alsodeia zeylanica* (Violaceae) (Seitz).

ISSORIA Hbn.

I. sinha Koll.—In Australia on *Xylosma ovatum*, *Homalium circumpinnatum* (Samydaceae) (Common).

CYNTHIA F.—*Modecca palmata* (Passifloraceae) (Seitz).

C. erota F.—*Modecca palmata* (Passifloraceae) (Bingham).

CIRROCHROA Dbl.—*Hydnocarpus wightiana* (Flacourtiaceae) (Seitz).

C. thais F.—*Hydnocarpus wightiana* (Flacourtiaceae) (Seitz).

Cethosiinae

CETHOSIA F.—Passiflorae (Seitz).

C. nietneri Feld.—*Modecca* (Peile, Moore), *Modecca palmata* (Bingham) (Passifloraceae).

C. biblis Drury—*Modecca* (Passifloraceae) but refused cultivated *Passiflora* (mihi), *Passiflora foetida* (Passifloraceae), *Balbas baquero* (? family ?) (Seitz).

C. cyane Drury—*Passiflora* (Passifloraceae) (Bingham, Seitz).

Argynnidi

MELITAEA F.

M. didyma O.—In Europe on *Plantago* (Plantagineae).

BOLORIA Moore

B. pales Schiff.—In Europe on *Viola* spp. (Violaceae).

ARGYNNIS F.

A. lathonia L.
A. adippe L. } In Europe on *Viola* spp. (Violaceae).
A. aglaia L.

A. hyperbius L.—*Viola* (Violaceae) (mihi). In Australia on *Viola* (Common).

Vanessidi

PRECIS Hbn.

P. iphita Cr.—*Strobilanthes* (Acanthaceae) (Bingham).

P. atlites L.—*Hygrophila spinosa* (Acanthaceae) (Seitz).

P. almana L.—*Acanthus*, (Acanthaceae), *Lippia nodiflora* (Verbenaceae), *Osbeckia* (Melastomaceae), *Gloxinia* (Gesneriaceae) (Seitz).

P. orithya L.—*Hygrophila* (Acanthaceae), *Antirrhinum orontium* (Scrophulariaceae) (Seitz), *Acanthus* (Acanthaceae) (Moore). In Australia on *Thunbergia alata* (Acanthaceae), *Antirrhinum* (Common). In East Africa on *Hygrophila* (Acanthaceae), *Englas scandens* (Labiatae), *Antirrhinum*, *Striga lutea* (Scrophulariaceae).

P. hierta F.—In East Africa on *Asystasia*, *Barleria*, *Justicia*, *Paulowilhelmia*, *Ruellia* (Acanthaceae).

PYRAMEIS Hbn.

P. cardui L.—*Artemisia*, *Blumea* (Compositae) (Bingham), *Artemisia* (Compositae) (Moore), *Carduus* (Compositae) (mihi). In Australia on *Helichrysum*, *Artemisia* (Compositae), *Cryptostemma* (? family ?) (Common). In East Africa on *Anchusa*, *Cyanoglossum*, *Echium* (Boraginaceae), *Arctium*, *Arctotis*, *Artemisia*, *Carduus*, *Chrysanthemum*, *Cirsium*, *Cynara scolymus*, *Filago*, *Gnaphalium*, *Heliochrysum*, *Laggera alata*, *Madia*, *Pentzia*, *Senecio*, *Sonchus*, *Stobaea* (Compositae), *Althaea*, *Malva* (Malvaceae), *Argyrolobium*, *Dolichos*, *Glycine*, *Lablab niger*, *Lupinus*, *Phaseolus* (Papilionaceae), *Boehmeria*, *Girardinia*, *Laporta*, *Urtica* (Urticaceae).

P. indica Herbst.—*Urtica* (Urticaceae) (Peile).

VANESSA F.

V. urticae L.—In Europe on *Urtica* (Urticaceae).

V. cashmirensis Koll.—*Urtica* (Urticaceae) (Peile, mihi).

V. xanthomelas Esp.—*Celtis australis* (Ulmaceae), *Pistacia integerrima* (Anacardiaceae), occasionally *Salix* (Salicaceae) (Seitz). In Europeon *Salix* (Salicaceae).

V. polychloros L.—In Europe on *Ulmus* (Ulmaceae), *Salix* (Salicaceae), *Prunus* (Rosaceae).

V. antiopa L.—In Europe on *Salix* (Salicaceae), *Urtica* (Urticaceae), *Betula* (Amentaceae).

V. canace L.—*Smilax* (Liliaceae) (Bingham, Moore, Seitz, mihi).

POLYGONIA Hbn.

P. c-album L.—In Europe on *Ulmus* (Ulmaceae), *Humulus*, *Urtica* (Urticaceae), *Prunus* (Rosaceae), *Ribes* (Ribesiaceae).

P. l-album Esp.—In Europe on *Salix*, *Populus* (Salicaceae).

P. egea Cr.—In Europe on *Parietaria officinalis* (Urticaceae).

ARASCHNIA Hbn.

A. prorsoides Blch.—*Urtica* (Urticaceae) (Seitz).

SYMBRENTHIA Hbn.

S. hippoclus Cr.—*Debregeasia bicolor*, *Girardinia heterophylla* (Urticaceae) (Seitz).

RHINOPALPA Feld.

R. polynice Cr.—*Conocephalus suaveolens* (Urticaceae) (Seitz).

HYPOLIMNAS Hbn.

H. misippus L.—*Portulaca oleracea* (Portulacaceae) (Bingham), *Abutilon* (Malvaceae), *Abelmoschus* (Malvaceae) (Moore), *Batatas* (Convolvulaceae), *Portulaca* (Portulacaceae), *Abutilon* (Malvaceae) (Seitz). In East Africa on *Asystasia, Justicia* (Acanthaceae), *Portulaca, Talium* (Portulacaceae). In Australia on *Pseuderanthemum* (Acanthaceae), *Portulaca* (Common).

H. bolina L.—Portulacaceae, Urticaceae (Seitz). In Australia on *Sida rhombifolia* (Malvaceae), *Asystasia scandens, Pseuderanthemum variable, Ruellia* (Acanthaceae), *Alternanthera denticulata* (Amaranthaceae), *Richardia* (Aroideae), *Synedrella* (Compositae) (Common).

DOLESCHALLIA Feld.—*Eranthemum malabaricum, Gratophyllum hortense* (Acanthaceae) (Seitz).

D. bisaltide Cr.—Acanthaceae (Moore), *Gratophyllum hortense* (Acanthaceae), *Urtica* (Urticaceae) (Seitz). In Australia on *Pseuderanthemum variable* (Acanthaceae) (Common).

KALLIMA Dbl.—*Strobilanthes callosus, Eranthemum malabaricum* (Acanthaceae) (Seitz).

K. inachus Bsd.—*Strobilanthus capitatus* (Acanthaceae), *Girardinia heterophylla* (Urticaceae), *Polygonum orientalis* (Polygonaceae) (Seitz).

K. philarchus Westw.—*Strobilanthus* (Acanthaceae) (Bingham), *Strobilanthus callosus, Eranthemum malabaricum* (Acanthaceae) (Seitz).

Marpesiidae

CYRESTIS Bsd.—*Ficus, Urostigma, Covellia* (Moraceae) (Seitz).

C. thyodamas Bsd.—*Ficus glomerata, F. nemoralis* (Peile), *Ficus indica* (Bingham).

CHERSONESIA Dist.—Possibly *Uvaria* sp. (Anonaceae), *Ficus* (Moraceae) (Seitz).

Neptididi

NEPTIS F.

N. jumbah Moore—Byttneriaceae, etc. (Moore), on 13 different plants belonging to the Malvaceae, Sterculiaceae, Tiliaceae, Rhamnaceae, Leguminosae and Urticaceae (Seitz).

N. **hylas** L.—Leguminosae (Moore), *Lathyrus* (Papilionaceae) (Seitz),

N. **soma** Moore—Malvaceae, Leguminosae, Urticaceae (Seitz).

N. **viraja** Moore—*Dalbergia latifolia*, *D. racemosa* (Papilionaceae) (Moore, Seitz).

RAHINDA Moore

R. **hordonia** Stoll.—*Acacia*, *Albizzia* (Mimosaceae) (Bingham).

PANTOPORIA Hbn.

P. **perius** L.—*Glochidion velutinum*, *G. lanceolatum* (Bingham), *Glochidion*, *Phyllanthus* (Seitz). (All Euphorbiaceae).

P. **ranga** Moore—*Olea dioica*, *Linociera malabarica* (Oleaceae) (Bingham, Seitz). N.B.—Seitz writes *Lonicera* for *Linociera*.

P. **opalina** Koll.—*Berberis aristata* (Berberidaceae) (Peile).

P. **selemophora** Koll.—*Adina cordifolia* (Rubiaceae) (Bingham).

P. **nefte** Cr.—*Glochidion velutinum G. zelanica* (Euphorbiaceae) (Bingham), *Glochidion* spp. (Euphorbiaceae), *Mussaenda frondosa* (Rubiaceae) (Seitz).

LIMENITIS F.

L. **procris** Cr.—*Mussaenda*, *Cinchona* (Rubiaceae) (Bingham, Moore), *Mussaenda frondosa*, *Wendenlandia*, *Nauclea cadamba* (Rubiacea) (Seitz).

L. **calidasa** Moore—*Mussaenda*, *Cinchona* (Rubiaceae) (Moore, Seitz).

PARTHENOS Hbn.—*Zehneria umbellata* (Cucurbitaceae) (Seitz).

P. **cyaneus** Moore—*Modecca* (Passifloraceae) (Bingham, Moore, Seitz).

Euthaliidi

EUTHALIA Hbn.

E. **lepidea** Btlr.—*Melastoma malabaricum* (Melastomaceae) (Bingham, Seitz), *Careya arborescens* (Myrtaceae) (Seitz).

E. **garuda** Moore—*Mangifera indica* (Anacardiaceae) (mihi), *Mangifera indica*, *Anacardium occidentale* (Anacardiaceae), *Loranthus scurrula* (Loranthaceae), *Bryonia* (Cucurbitaceae), *Morus* (Moraceae), *Rosa* (Rosaceae), *Trophis aspera* (? family ?) (Seitz).

E. **vasanta** Moore—*Mangifera indica* (Anacardiaceae) (Moore, Seitz).

E. **anosia** Moore—*Mangifera indica* (Anacardiaceae) (Seitz).

E. phemius Dbl.—*Nephelium litchi* (Sapindaceae) (Seitz).

E. lubentina Cr.—*Loranthus* (Loranthaceae) (Moore, Seitz).

E. nais Forst.—*Diospyros* (Ebenaceae) (Peile), *Diospyros melanoxylon* (Ebenaceae) (Seitz).

E. evelina Stoll.—*Diospyros candolleana* (Bingham), *Diospyros candolleana, D. melanoxylon* (Ebenaceae) (Seitz).

Apaturidi

APATURA F.

A. parisatis Westw.—*Celtis lycodoxylon* (Ulmaceae) (Moore, Seitz).

A. ambica Koll.—*Ulmus wallichiana* (Ulmaceae) (Seitz).

EURIPUS Westw.—Urticaceae (Seitz).
E. consimilis Westw.—*Trema orientalis* (Urticaceae) (Seitz).

Charaxidi

ERIBOEA Hbn.

E. athamas Drury—*Delonix regia* (Caesalpinaceae), *Acacia pennata, A. coesia, Albizzia lebbek* (Mimosaceae) (Peile). *Caesalpinia* (Caesalpinaceae) (Moore), *Grewia* (Tiliaceae), *Caesalpinia, Poinciana* (Caesalpinaceae), *Albizzia milletti, Acacia* (Mimosaceae), *Alsicia* (? family ?) (Seitz).

E. schreiberi Godt.—*Nephelium lappaceum* (Sapindaceae), *Rourea santaloides* (Connaraceae), *Cynometra caulifora, Wagatea spicata* (Caesalpinaceae) (Seitz).

CHARAXES O.

C. fabius F.—*Tamarindus indicus, Wagatea spicata* (Caesalpinaceae), ' occasionally noticed on Cardenia ' (? family ?), possibly a misprint for *Gardenia* (Rubiaceae) (Seitz).

C. polyxena Cr.—*Saccopetalum* (printed *Saroptalum*) *tomentosum* (Anonaceae) (Peile), *Saccopetalum tomentosum* (Anonaceae), *Aglaia roxburghiana* (Meliaceae) (Seitz).

ERYCINIDAE

Libytheini

LIBYTHEA F.

L. celtis Fuessl.—In Europe on *Celtis australis* (Ulmaceae).

L. **lepita** Moore—*Celtis* (Ulmaceae) (Seitz).

L. **myrrha** Cr.—*Celtis tetrandra* (Ulmaceae) [Bingham, Seitz (printed *tetranta*)].

Riodinini

ZEMEROS Bsd.

Z. **flegyas** Cr.—*Maesa montana* (Bingham), *Maesa chisia* (mihi) (Myrsinaceae).

DODONA Hew.—On *Maesa* (printed *Moesa*) (Myrsinaceae), Gramineae and alpine bamboo (Gramineae) (Seitz).

D. **eugenes** Bates—Grasses, Hill Bamboo (Bingham), Gramineae, Alpine Bamboo (Gramineae) (Seitz). I am doubtful of the correctness of this record.

D. **adonira** Hew.—*Maesa chisia* (Myrsinaceae) (mihi), *Moesa* (sic) *chisia* (Seitz).

D. **ouida** Moore—*Maesa chisia* (Myrsinaceae) (mihi).

ABISARA Feld.—Myrsinaceae (Seitz).

A. **fylla** Hew.—*Maesa chisia* (Myrsinaceae) (mihi).

A. **echerius** Stoll.—*Ardisia* (Myrsinaceae) (Moore), Myrsinaceae (Seitz).

LYCAENIDAE

Liphyrinae

LIPHYRA Westw.

L. **brassolis** Westw.—Carnivorous on Ant larvae (Bingham). Also in Australia (Common). Seitz writes ' Holland's presumption that the larvae are carnivora, is due to a rather ingenious and for the present uncontrollable combination '.

Gerydinae—Carnivorous on aphides (Seitz).

GERYDUS Bsd.

G. **biosduvali** Moore—Carnivorous on aphides (Seitz).

Lycaeninae

MEGISBA Moore

M. **malaya** Hors.—Sapindaceae (Moore).

LYCAENOPSIS Feld.

L. puspa Horsf.—*Cylista scariosa* (Papilionaceae), *Xylia dolabriformis* (Mimosaceae), *Hiptage madablota* (Combretaceae), *Schleichera trijuga* (Sapindaceae) (Seitz).

L. argiolus L.—In Europe on *Rhamnus* (Rhamnaceae), *Hedera* (Araliaceae), *Ilex* (Ilicineae).

PITHECOPS Horsf.—Leguminosae (Seitz).

P. hylax F.—Leguminosae (Seitz).

P. zalmora Btlr.—*Glycosmis pentaphylla* (Rutaceae) (Seitz). Also in Australia (Common).

SPALGIS Moore—Carnivorous feeding on the Aphid *Dactylopius adonideum* (Seitz).

S. epius Moore—Euphorbiaceae (Moore). Almost certainly incorrect, the real food being Aphids feeding on the Euphorbiaceae.

CASTALIUS Hbn.

C. ananda de N.—*Zizyphus xylopyrus* (Rhamnaceae), *Loranthus* (Loranthaceae) (Bingham).

C. rosimon F.—*Zizyphus jujuba* (Rhamnaceae) (Peile, Bingham, Seitz).

C. ethion Dbl.—*Zizyphus jujuba*, *Z. xylopyrus* (Rhamnaceae) (Seitz).

C. caleta Hew.—*Zizyphus rugosa* (Rhamnaceae) (Bingham).

TARUCUS Moore—*Zizyphus jujuba* (Rhamnaceae) (Seitz).

T. plinius F.—*Plumbago* (Plumbaginaceae) (Bingham). Also in Australia (Common). In East Africa on *Burkea*, *Crotalaria*, *Indigofera*, *Medicago*, *Melilotis*, *Mundulea*, *Phaseolus*, *Pisum*, *Sesbania* (Papilionaceae), *Plumbago* (Plumbaginaceae).

T. theophrastus F.—*Zizyphus* (Peile), *Zizyphus jujuba* (Bingham) (Rhamnaceae). Also in East Africa.

T. nara Koll.—*Zizyphus* (Peile), *Zizyphus jujuba* (mihi) (Rhamnaceae).

AZANUS Moore

A. ubaldus Cr.—*Acacia* sp. (Peile), *Acacia arabica* (Seitz) (Mimosaceae).

A. uranus Btlr.—*Acacia* sp. (Peile), *Acacia arabica*, *A. senegal* (Seitz) (Mimosaceae).

A. jesous Guer.—In East Africa on *Acacia* (Mimosaceae), *Medicago* (Papilionaceae).

COSMOLYCE Tox.

C. boeticus L.—*Cajanus indicus*, *Butea frondosa* (Peile), *Crotalaria striata* (Bingham), *Lupinus*, *Pisum* (mihi), *Vigna sinensis*, *Melilotus*, *Crotalaria striata* (Seitz). In Australia on *Crotalaria*, *Dolichos*, *Sesbania*, *Lupinus*. In East Africa on *Cajanus cajan*, *Canavallia*, *Colutea*, *Crotalaria*, *Indigofera*, *Lathyrus*, *Lupinus*, *Medicago*, *Phaseolus*, *Pisum*, *Podalyria*, *Sutherlandia*, *Virgilia*. All Papilionaceae.

LYCAENESTHES Moore

L. emolus Godt.—*Nephelium litchi* (Sapindaceae), *Heynea trijuga* (Meliaceae), *Cassia fistula* (Caesalpinaceae) (Bingham, Seitz). In Australia on *Caesalpinia nuga*, *Cassia* (Caesalpinaceae), *Pongamia pinnata* (Papilionaceae), *Clerodendron* (Verbenaceae), *Cupaniopsis anacardioides* (? family ?), *Faradaya splendida* (? family ?) (Common).

JAMIDES Hbn.

J. bochus Cr.—*Xylia dolabriformis* (Mimosaceae), *Butea frondosa* (Papilionaceae) (Bingham, Seitz).

LAMPIDES Hbn.

L. celeno Cr.—*Heynea trijuga* (Meliaceae) (Bingham), *Heynea trijuga* (Meliaceae), *Butea frondosa* (Papilionaceae), ‘ but presumably also on other plants, such as Cardamomae ’ (Seitz).

L. elpis Godt.—*Kaempferia pandurata*, *Elettaria cardamomum* (Zinziberaceae) (Bingham, Seitz).

NACADUBA Moore

N. berenice H. Sch.—In Australia on *Cupaniopsis* (? family ?), *Alectryon* (? family ?) (Common).

N. atrata Horsf.—*Embelia robusta* (Sapotaceae) (Bingham).

N. perusia Feld.—*Vateria indica* (Dipterocarpaceae) (Moore).

CATOCHRYSOPS Bsd.

C. cnejus F.—*Phaseolus trilobus*, *Dolichos catjang* (Papilionaceae) (Bingham, Seitz). In Australia legume flowers (Common).

C. pandava Horsf.—*Cycas revoluta* (Cycadaceae) (Bingham, Seitz), Cycadaceae (Moore).

EVERES Hbn.

E. **argiades** Pall.—*Trifolium*, etc. (Papilionaceae) (Bingham).

TALICADA Moore

T. **nyseus** Geur.—*Bryophillum calycinum* (Crassulaceae) (Bingham, Seitz), *Bryophillum* (Moore).

ZIZERA Moore

Z. **lysimon** Hbn. (=*Zizeeria knysna* Trim.)—*Zornia diphylla* (Papilionaceae) (Bingham). In Australia on *Tribulus terrestris* (Zygophyllaceae) (Common). In East Africa on *Amaranthus* (Amaranthaceae), *Euphorbia* (Euphorbiaceae), *Oxalis* (Oxalidaceae), *Medicago*, *Zornia* (Papilionaceae), *Tribulus* (Zygophyllaceae).

Z. **gaika** Trim. (= *Zizula hylax* F.)—In East Africa on *Oxalis* (Oxalidaceae).

Z. **otis** F.—In Australia on Legumes including *Medicago* (Papilionaceae) (Common).

Z. **maha** Koll.—*Oxalis corniculata* (Oxalidaceae) (mihi).

CHILADES Moore

C. **trochilus** Frr.—*Heliotropium strigosum* (Boraginaceae) (Bingham), *Rhynchosia minima* (Papilionaceae) (mihi). In Australia on *Indigofera* (Papilionaceae) (Common). In East Africa on *Indigofera*.

C. **laius** Cr.—*Citrus* spp. (Rutaceae) (Bingham, mihi).

LYCAENA F. (=*Polyommatus* Latr.)

L. **astrarche** Bgster.—In Europe on *Erodium cicutarium* (Geraniaceae).

L. **cyllarus** Rott.—In Europe on Leguminosae.

L. **icarus** Rott.—In Europe on Leguminosae, especially on *Ononis spinosa* (Papilionaceae).

CHYSOPHANUS Hbn. (=*Lycaena* F.)

C. **phlaeas** L.—*Rumex nepalensis* (Polygonaceae) (Peile). In Europe on *Rumex* spp.

ILERDA Dbl. (=*Heliophorus* Geyer)

I. **brahma** Moore—*Rumex* (Polygonaceae) (mihi).

I. **sena** Koll.—*Rumex hastatus* (Polygonaceae) (Peile).

CURETIS Hbn.

C. **bulis** Dbl.—*Pongamia glabra* (Papilionaceae) (Bingham).

APHNAEUS Hbn.

A. **lohita** Horsf.—Convolvulaceae (Moore).

APHARITIS Riley

A. **acamas** Klug—*Cassia* (Caesalpinaceae) (Seitz).

IRAOTA Moore

I. **timoleon** Stoll.—*Ficus glomerata* (Peile), *F. religiosa* (Moore) (Moraceae).

AMBLYPODIA Horsf.—On *Schleichera* (Sapindaceae), *Lagerstroemia* (Lythraceae), *Xylia* (Mimosaceae), *Hopea* (Styraceae), etc. (Seitz).

A. **apidanus** Cr.—*Eugenia* (Myrtaceae), *Lagerstroemia* (Lythraceae) (Seitz).

A. **centaurus** F.—*Schleichera trijuga* (Sapindaceae) (Moore).

A. **dodonaea** Moore
A. **rama** Koll. } *Quercus incana* (Fagaceae) (Peile).
A. **ganesa** Moore

ZEPHYRUS Dalm.

Z. **birupa** Moore—*Rhododendron arboreum* (Ericaceae) (Peile).

CHAETOPROCTA de Nic.

C. **odata** Hew.—*Juglans* (Juglandaceae) (Peile).

CAMENA Hew. (=*Pratapa* Moore)

C. **deva** Moore—*Loranthus tomentosa* (Loranthaceae) (Peile, Seitz).

TAJURIA Moore

T. **cippus** F.—*Loranthus* (Loranthaceae) (Moore, Seitz).

T. **melastigma** de Nic.—*Loranthus* (Loranthaceae) (Seitz).

T. **jalindra** Horsf.—*Loranthus elastica* (Loranthaceae) (Seitz).

T. **cleobis** Godt.—*Loranthus elastica* (Loranthaceae) (Seitz).

T. **diaeus** Hew.—*Loranthus bicolor* (Loranthaceae), *Lantana* (Verbenaceae) (Seitz).

HORAGA Moore

H. onyx Moore—*Coriaria nepalensis* (Coriariaceae) (Seitz).

HYPOLYCAENA Feld.

H. erylus Godt.—*Vangueria spinosa* (Rubiaceae) (Seitz).

RATHINDA Moore

R. amor F.—*Eugenia ceylonica* (Myrtaceae), *Hopea* (Styraceae) and presumably on some other plants (Seitz), *Ixora coccinea* (Rubiaceae), *Nephelium litchi* (Sapindaceae) (mihi).

CHERITRA Moore

C. freja F.—*Xylia dolabriformis* (Mimosaceae) (Seitz).

LOXURA Horsf.

L. atymnus Cr.—*Smilax* (Smilacaceae) (Moore), *Dioscorea* (Dioscoraceae) (Seitz).

ZEZIUS Hbn.

Z. chrysomallus Hbn.—*Terminalia* (Combretaceae) (Moore), *Terminalia tomentosa, T. paniculata* (Combretaceae), *Xylia dolabriformis* (Mimosaceae) (Seitz).

DEUDORYX Hew.—In fruits (Seitz).

D. epijarbas Moore—*Punica granatum* (Lythraceae), *Aesculus* (Hippocastaneae) (Peile), *Connarus ritchiei* (Connaraceae), *Punica* (Lythraceae), *Aesculus indicus* (Hippocastaneae) (Seitz). In Australia in fruits of *Harpullia pendula* (Sapindaceae) (Common).

D. perse Hew.—*Randia dumetorum* (Rubiaceae) (Seitz).

D. isocrates F.—*Punica* (Lythraceae) (Peile), *Punica granatum* (Lythraceae), *Psidium guajava* (Myrtaceae), *Eriobotrya japonica* (Rosaceae), *Randia dumetorum, R. uliginosa* (Rubiaceae) (Seitz).

RAPALA Moore

R. melampus Cr.—*Nephelium lappaceum* (Sapindaceae), *Melastoma polyanthus* (Melastomaceae), *Zizyphus rugosus* (Rhamnaceae), *Ougeinea dalbergeoides* (Papilionaceae) (Seitz).

R. selira Moore—*Indigofera purpurea* (Papilionaceae) (Peile).

R. varuna Horsf.—*Lantana camara* (Verbenaceae), *Zizyphus xylopyrus* (Rhamnaceae) (Seitz).

R. sphinx F.—*Melastoma polyanthus* (Melastomaceae), *Elaeagnus ferruginea* (Elaeagnaceae) (Seitz).

R. schistacea Moore—*Quisqualis indica* (Combretaceae) (mihi), *Quisqualis* (Combretaceae), *Acacia caesia* (Mimosaceae), *Spiraea sorbifolia* (Rosaceae) (Seitz).

HESPERIIDAE

Hesperinae

COLADENIA Moore

C. dan F.—*Achyranthes aspera* (Amarantaceae) (Seitz).

CELAENORRHINUS Hbn.

C. asmara Btlr.—*Clerodendron fragrans* (Verbenaceae) (Seitz).

C. plagifera de N.—*Impatiens* (Balsamineae) (mihi).

TAGIADES Hbn.—Roxburghiaceae, Dioscoraceae, Convolvulaceae (Seitz).

T. japetus Cr.—*Dioscorea oppositifolia* (Dioscoraceae) (Seitz).

ODONTOPTILUM de N.

O. angulata Feld.—*Hibiscus tiliaceus*, *Urena lobata*, *Eriodendron* (Malvaceae), and other plants (Seitz).

HESPERIA Latr.

H. galba F.—*Sida rhombifolia* (Malvaceae) (mihi).

CARCHARODUS Hbn.

C. alcae Esp.—In Europe on Malvaceae.

Ismeninae

HASORA Moore

H. badra Moore—*Derris uliginosa* (Bell), *Pongamia volubilis* (Seitz) (both Papilionaceae).

H. alexis F.—*Pongamia glabra* (Papilionaceae) (Bell). Also in Australia (Common).

H. butleri Auriv.—*Derris scandens* (Papilionaceae) (Bell).

H. vitta Btlr.—*Millettia racemosa*, *M. auriculata* (Papilionaceae) (Bell).

BIBASIS Moore

B. sena Moore—*Combretum extensum* (Combretaceae) (Bell), *Combretum latifolium* (Seitz).

BADAMIA Moore

B. exclamationis F.—*Terminalia bellerica* (Combretaceae) (Bell). In Australia on *Terminalia* (Common).

ISMENE Swains.

I. harisa Moore—*Zinziber zerumbet* (Zinziberaceae) (Seitz).

I. gomata Moore—*Heptapluron venulosum* (Araliaceae) (Bell), *Heptapluron lucidum* (Araliaceae), *Embelia garciniaefolia* (Myrsinaceae), *Trevesia sondaica* (Araliaceae), *Horsfieldia* (Myristicaceae), etc. (Seitz).

I. oedipodea Swains.—*Combretum latifolium* (Combretaceae) (Seitz).

I. jaina Moore—*Combretum extensum* (Combretaceae) (Bell).

RHOPALOCAMPTA Wallgrn.

R. benjamini Guer.—*Sabia campanulata*, *Meliosma pungens* (Sabiaceae) (Bell).

Pamphilinae

SUASTUS Moore

S. gremius F.—Palms (mihi), *Caryota urens* and other Palms (Palmaceae) (Bell).

IAMBRIX Wats.

I. salsala Moore—Grasses (Bell), Bamboo (Seitz) (both Gramineae).

I. stillifer Btlr.—Bamboo (Gramineae) (Seitz).

AEROMACHUS de Nic.

A. stigmata Moore—Grasses (Gramineae) (mihi).

A. discreta Plotz—Grasses (Gramineae) (Bell).

HYAROTIS Moore

H. adrastus Cr.—*Phoenix* (Bell), Rotang and Phoenix Palms (Seitz) (Palmaceae).

MATAPA Moore

M. aria Moore—Bamboo (mihi, Bell, Seitz) (Gramineae).

ERIONOTA Mab.

E. thrax L.—*Musa* spp. (Musaceae) (Bell), *Musa* and other Monocotyledons such as *Saccharum* (Gramineae), *Cocos nucifera*, *Rhaphis* (Palmaceae), *Metroxylon* (Palmaceae) (Seitz).

GANGARA Moore

G. thyrsis F.—Palmaceae (Moore), *Calamus*, *Cocos nucifera*, *Caryota urens* and other Palms (Bell), Palms, particularly on cocoanut (sic) trees and dwarf palms, but it is said to occur also on ratan, *Calamus rotang*, and other Monocotyledons (Seitz).

SANCUS de Nic.

S. pulligo Mab.—*Phrynium spicatum* (Marantaceae) (Bell), a common Arum (Araceae) (Seitz).

BARACUS Moore

B. hampsoni Elw.—Grasses (Gramineae) (Bell).

AMPITTIA Moore

A. dioscorides F.—*Oryza* (Gramineae) (Bell, Seitz).

TARACTROCERA Btlr.

T. maevius F.—Grasses (Gramineae) (Bell).

T. nicevillei Wats.—Grasses, *Oryza* (Gramineae) (Bell).

PADRAONA Moore

P. gola Moore—Grasses (Gramineae) (Bell), *Imperata arundinacea*, *Paspalum conjugatum* (Gramineae) (Seitz).

P. dara Koll.—*Paspalum conjugatum* (Gramineae) (Seitz).

TELICOTA Moore

T. bambusae Moore—Bamboo (Bell, mihi), bamboo, *Saccharum* (Seitz) (all Gramineae).

T. augias L.—*Saccharum*, *Oryza*, Bamboo (Gramineae) (Bell). In Australia on *Flagellaria indica* (Gramineae) (Common).

T. palmarum Moore—*Cocos nucifera*, *Phoenix* (Bell), *Cocos nucifera*, *Calamus rotang* (Seitz) (all Palmaceae).

T. maesoides Koll.—*Bambusa*, *Oxytenanthera*, *Dendrocalamus*, *Teinostachyum* (Gramineae) (Bell).

GEGENES Hbn.

G. nostrodamus F.—Grasses (Gramineae) (Bell), *Oryza* (Gramineae) (Seitz).

PARNARA Moore

P. philippina H. Sch.—Bamboo (Bell), presumably on *Oryza, Saccharum*, Bamboo (Gramineae), perhaps also on Palms (Palmaceae) (Seitz).

P. guttatus Brem.—Grasses, *Oryza, Saccharum*, Bamboo (Bell), *Oryza, Zea mays, Saccharum*, Bamboo (Seitz). All Gramineae.

P. colaca Moore—Grasses, *Oryza* (Bell), *Oryza* (Seitz) (Gramineae), Gramineae (Moore).

P. bevani Moore—*Saccharum, Paspalum conjugatum, Imperata arundinaceae* (Gramineae) (Seitz).

P. kumara Moore—*Imperata arundinaceae* (Gramineae) (Seitz), Bamboo (Gramineae) (Bell).

P. oceia Hew.—*Bambusa arundinaceae, Ochlandra talboti* (Gramineae) (Bell), *Saccharum* (Gramineae) (Moore).

P. canaraica Moore—Bamboo (Gramineae) (Bell).

P. mathias F.—Grasses (Bell), *Oryza, Saccharum* and other Gramineae (Seitz).

P. subochracea Moore—Grasses (Gramineae) (Bell).

P. zelleri Led.—Grasses (Gramineae) (Bell).

HALPE Moore

H. astigmata Swinh. **H. moorei** Wats. **H. hyrtacus** de Nic. **H. honorei** de Nic.	Bamboo (Gramineae) (Bell).

PLASTINGIA Btlr.

P. submaculata Stg.—*Calamus subtenuis* (Palmaceae) (Bell).

CUPITHA Moore

C. purreea Moore—*Combretum ovalifolium, Terminalia bellerica, T. paniculata* (Combretaceae), *Ehretia laevis* (Boraginaceae) (Bell).

PIRDANA Dist.

P. hyela Hew.—*Dracaena, Cordyline rumphii* (Liliaceae) (Seitz).

NOTOCRYPTA de Nic.

N. curvifascia Feld.—*Curcuma* (Zinziberaceae) (Seitz).

N. restricta Moore—*Zinziber casumunar*, *Curcuma decipiens* (Zinziberaceae) (Bell).

N. feisthameli Bsd.—*Zinziber casumunar*, *Curcuma decipiens* (Bell). *Zinziber* (mihi). All Zinziberaceae.

N. alysos Moore—Zinziberaceae (Moore).

UDASPES Moore

U. folus Cr.—*Curcuma decipiens* and other Zinziberaceae (Bell), *Curcuma* (Zinziberaceae), *Fagraea racemosa* (Loganiaceae) (Seitz).

KERANA Dist.

K. diocles Moore—*Zinziber*, *Curcuma* (Zinziberaceae) (Seitz).

PADUCA Dist.

P. lebadea Hew.—Palmaceae (Moore), *Calamus* (Palmaceae) (Seitz).

UNKANA Dist.

U. attina Hew.—*Pandanus fascicularis* (Pandaneae), *Psychotria* sp. (Rubiaceae) (Seitz).

HIDARI Dist.

H. ivava Moore—Various palms, particularly *Cocos nucifera* and *Caryota urens* (Palmaceae) (Seitz).

N.B.—In most of the works consulted, the spelling of the botanical names leaves much to be desired, Seitz is particularly bad, the same name often appearing twice on the same page with different spellings.

Reviews

1. BEHAVIOUR OF WOLVES, DOGS AND RELATED CANIDS.

By M. W. Fox. pp. 214 (16×24 cm) with numerous black-and-white photographs and line drawings. London, 1971. Jonathan Cape. Price £3.60 net.

In the sub-family Canidae only the wolf forms permanent packs. Family groups of coyotes and jackals may hunt together for a time, but foxes drive their young away early, and the breeding pair often separate also. The author of this interesting book shows that though these species have the same basic behaviour patterns, these have become more complex in the more social species. New facial expressions have evolved, often combining more than one primitive expression. Interestingly these complex expressions appear later in the development of cubs than do the primitive ones common to all species. The domestic dog is believed to have evolved from a wolf-like ancestor, but it has been suggested, and not yet conclusively disproved, that in some parts of the world primitive man domesticated the jackal. As a result of selective breeding some behaviour patterns have atrophied, others hypertrophied, and yet others have acquired a new significance, so no clue as to origin can be obtained from behaviour. Dog owners will be intrigued to know that when two dogs circle one another this is the same behaviour as that of young pups, which circle each other until they fall asleep in a tight warm heap. This is only one of a number of infantile behaviour patterns which persist, and are incorporated in a changed form into adult behaviour.

Dr. Fox's observations have been on hand-raised canids, which he compares with field data whenever possible. The wolves are by far the most attractive subjects, and there are some fascinating chapters on the development of dominance in wolves and on wolves as parents. Observations both on captive and on wild wolves indicate that normally only one pair in a pack breeds and that the dominant wolf is not one of them. All the members of the pack co-operate in looking after the cubs. This is a population-regulating mechanism. In addition, in the wild numbers are controlled by the availability of prey species, and when there is little food there is high mortality among pups. On page 128 the author cites a number of authorities who believe that there is no reduction in the number of pups born in lean year, and yet on pages 113-114 he hypothesises, apparently without data, that poor nutrition could lead to infertility and resorption of fœtuses. There seems to be no good reason for the subject to be discussed in two different places. Another subject that is discussed at some length is submission, and its function in social organisation. Some dominance-submission rituals would in a human context be interpreted as affection, and the term ' love ' is used here. This seems unnecessarily anthropomorphic, and also inappropriate as the word has a wider meaning than that to which it is restricted here.

The photographs in this book are excellent throughout, but the writing is often awkward. Lay readers will find the jargon in some of the earlier chapters particularly trying. It is difficult to imagine anyone being helped by descriptions like ' dorsal vertical postero-horizontal retraction of lips ', meaning a simultaneous grin and a snarl. Often there does not seem to be any connection between sub-titles and subject matter. This is due to poor organisation. For example, a discussion of the development in hand-reared wolf cubs of allegiances to pack members and nervousness of strangers occurs at the end of a section on mate preferences, when it belongs at the beginning of the same chapter, which deals with social organisation, or perhaps in another chapter entitled ' Development of Social Relationships: Wolf Socialisation '. It is to be hoped that these irritations will be corrected in future editions.

One would now like to have a comparison between wolf socialisation and that of the dhole, the South American bush dog, and the Cape hunting dog, all pack-hunters which belong to the sub-family Simocyoninae. These lack the range of complex facial expressions which characterise the wolf, and apparently do not all show dominance. Dr. Fox is the obvious person to make these comparisons and I hope that he will do so before too long.

R. R.

2. INSECT POLLINATION. By J. B. Free. pp. xi + 544 (15×23 cm) with 170 figures. London & New York, 1970. Academic Press. Price £7.25.

This reviewer is indeed struck by the wealth of information this book possesses. It reviews all the important information on the subject into a most comprehensive volume and makes it a very valuable reference work on pollination of the most important crops of temperate regions. ' Although there are many facets of pollination of different crops that are similar, it is very striking how many crops have their own unique pollination problems.'

The author who is connected with the Rothamsted Experimental Station, Hampenden, Herts, England, is without doubt fully conversant with this subject. In the first part of the book, he has discussed the pollinating insects—particularly the honey bee and points out how it can be used by man to supplement wild pollinators and the ways in which this can be done most effectively.

In the second part, each crop—over a hundred treated in the book—is discussed individually. In every case the flower structure as related to the pollination is effectively illustrated. The insect species which are reported to pollinate the flower together with the crop's pollination requirement are specifically mentioned. Admittedly the information from tropical crops is rather sparse and it is felt that lack of sufficient pollination may be one of the reasons for only a small proportion of fruit and seed set in the tropics.

The book is written very lucidly and the simple and logical way in which the process is explained in each case should inspire anyone who wishes to carry out useful work on this fascinating and highly important aspect of biological productivity in nature. In the context of the present whole-scale use of insecticides, the publication of the book is timely and worthy of serious attention by agriculturists, horticulturists and foresters in India. The book opens an immense scope of similar type of work to be carried out in India and the tropics. The book contains about 1500 reference titles, a separate index of plant names, also of animal names and a general index. All the above features make this book a very valuable and important reference work in the field of reproduction of crop plants.

P. V. B.

3. THE NATURAL HISTORY OF SHARKS. By Thomas H. Lineaweaver III & Richard H. Backus. pp. 256 (22 × 14 cm). London, 1970. André Deutsch Limited. Price £2.75 net U.K. only.

Until recent years, man had not succeeded in crossing the boundary that separated him from the world of marine life. He had never observed sharks in their natural habitat, except in a few brief and involuntary encounters, as in a shipwreck, and mostly ending in disaster for him. Brought face to face with these marine monsters, man's perplexity has been considerable, and his attitude variable. The first emotion was, understandably, terror. And, as always when fear plays a part, legends about sharks multiplied.

The increasing tempo of undersea exploration, aided mainly by scuba diving and submersibles, has led to increased exploration, so that much more is known about sharks. And, after all, there is nothing simple about any aspect of the relations between the monarch of the sea and the ruler of the lands of the earth. The result is that numerous books dealing specifically with sharks have appeared during the last several years. These books have covered the subject reasonably well, and one or two could be classified as superb. The present one is rather a late-comer on the scene.

Starting, in the first chapter, by summarizing the differences between sharks and bony fishes, the authors go on to an inventory of things found in sharks' stomachs, and the few animals inside whose stomachs sharks have sometimes been found. The third chapter describes the habits, factual and fancied, of two constant companions of the shark, pilot fish and remoras. The fourth chapter is a listing and analysis of shark attacks on man. Chapters 5 to 10 relate to the different kinds of sharks found both in the seas and in fresh water. Chapter 11 is a review of the reproduction, or rather, whatever little is known about it. Chapter 12 deals with sense organs and anatomy. The final chapter tackles the problem most vital to man when he faces a shark in its own element—survival.

A key to the families of sharks, prepared by Dr. John Musick, is given towards the end, followed by a glossary which will be of little use to ichthyologists already familiar with biological nomenclature but will be of considerable use to non-scientists who might be newly involved in the study of sharks. The bibliography, at the very end, is only a brief listing, but is meant to be sufficient for the layman to follow up.

A good deal of researching into earlier literature, especially scientific papers, must have gone into the writing of the book, and the book is excellently edited, with no technical mistakes. The fact that the senior author is not a professional biologist, but a journalist, does not reduce the scientific value of the book.

But the greatest difficulty with collections of this type is the lack of focus, and the frequent mention of sources and dates in the text tends to slow down the narrative. A few of the chapters are quite interesting, but a large part of the space used in the book presents a rehash of information that has been previously published over and over again.

The photographs are uninspiring, and the drawings shoddy (although, here, I might add that my opinion might have been prejudiced because this book happened to be reviewed immediately after seeing the excellent quality of the colour photographs in Jacques-Yves and Philippe Cousteau's book THE SHARK : SPLENDID SAVAGE OF THE SEA).

A valuable source book.

B. F. C.

4. PATTERNS OF CHANGE IN TROPICAL PLANTS. By G. P. Chapman. pp. 112 (21·5 × 14 cm) with 9 plates and 12 figures. London, 1970. University of London Press Ltd. Price £1.00.

The quotation on the title page ' Botanical teaching based on the temperate flora must necessarily be ill-based and inadequate ' C.G.G.J. van Steenis—defines the objective of this little but most valuable book. The author aims to indicate the value of cytogenetics in understanding the process of plant speciation and in the case of crop plants he wishes to point out how these processes can be turned to our advantage. With the help of examples of some well-known taxa viz. Casuarina, Catharanthus, Euphorbia, Musa, Lycopersicon, Dichanthium, Maize, etc. the author has discussed the processes of reproduction and plant breeding in the past.

The author succeeds in building up an optimistic picture of food production in the tropics while advocating intensive research on evolutionary patterns of other tropical plant species of agricultural interest.

In his concluding remarks, the author brings out clearly the need for more botanists to live and work in the tropics for several years, experiencing at first hand the march of environmental change and plant response. He is aware of the fact that every aspect of botany will not develop equally in the tropics but commends the important activity of continuing appraisal and reappraisal of traditional systematics followed by the work of an evolutionist and plant breeder who can recognise the tropics as the area of greatest potential interest.

This little book must be read by all botanists in the tropics—especially in India—where a new phase of agricultural development has been ushered in and many of our food plants like pulses, oil seeds, spices, etc. can be developed with better understanding of reproductive processes in tropics.

P. V. B.

5. ECOLOGY AND BIOGEOGRAPHY OF HIGH ALTITUDE INSECTS—SERIES ENTOMOLOGICA VOLUME 4. By M. S. Mani. pp. xiv + 527 (25 × 16 cm) with 79 figures. The Hague, 1968. W. Junk N.V. Publishers.

Professor Mani's studies on high altitude entomology in the Himalayas are well-known. In this book he discusses in general climatic conditions at high altitudes, and the adaptations which make it possible for insect life to survive. He then goes on to describe in detail the physiography, vegetation, and insect fauna of each of the major mountain ranges in the world. The flora and fauna of a mountain have partly evolved from the lowland species of the area at the time when the mountain range was uplifted, and have been remoulded at every phase of the slow process of rising. Other species have colonised the mountain from the lowland or from distant mountain ranges. Then there are relict species which have survived glaciations on widely separated high mountains though extinct elsewhere. Specialisation has everywhere tended to produce local subspecies and races, some restricted to a single peak.

This comprehensive book is likely to be an essential reference book on this subject for a long time to come. There are 1141 papers cited.

R. R.

6. CEDRUS. BOTANICAL MONOGRAPH NO. 5. By P. Maheshwari and Chhaya Biswas. pp. 115 (16·5×24·5 cm) with 55 figures. New Delhi, 1970. Council of Scientific and Industrial Research. Price Rs. 24, *sh.* 48, $8.

This botanical monograph has been the last one in which the celebrated Indian botanist, late Professor P. Maheshwari actively participated. In fact, the other author points out in the footnote of the preface, Prof. Maheswari passed away when the manuscript was almost completed for the press. This monograph gives an excellent account of the phytomorphology of the genus *Cedrus*. The major part of the text deals with *Cedrus deodara*, one of the most valuable timbers found in India.

Of the 108 pages of the text, 90 are taken up by phytomorphology—53 dealing with embryology. Eighteen pages are utilised to give a résumé of cytological studies, phytopathology, ecology, sylviculture and economic importance of the genus. The illustrations are excellent and take about 50 pages.

Figure no. 55 giving time relation of *Cedrus deodara* is interesting. It appears that one of the figures of years (June 1956 or January 1957) needs correction in view of the explanation in the relevant table and text—18 months from June 1956 should make 1958 January.

The Introduction gives 4 interesting biblical and Chinese legends on Cedar wood. It would have been in the fitness of this monograph to mention a few from ancient Indian literature wherein ' Devdaru ' is well-known. This monograph forms a valuable review of the phytomorphological studies of the genus *Cedrus* and will certainly prove useful in that field of study with its comprehensive bibliography. In view of its economic importance to lumber and perfumery industry, further ecological and sylvicultural studies of this most valuable of temperate conifer in India appear desirable.

The production values of the publication are kept very high and the printers must be congratulated along with the artists for good reproduction of figures and photographs.

P. V. B.

Miscellaneous Notes

1. ECOLOGICAL AND BEHAVIOURAL NOTES ON THE LIONTAILED MACAQUE (*MACACA SILENUS*) IN SOUTH INDIA

The Liontailed Macaque (*Macaca silenus*) has the most restricted range of all primates of the Indian subcontinent, where it is restricted to the evergreen forest of the Western Ghats (Krishnan 1971). Blanford (1888) indicated that the species occurs from 14°N. to the southern limits of the Western Ghats while Sugiyama (1968) found the species between 9°30′ and 11° 30′N. Krishnan (1971) indicates that it is no longer present in the forests of Thirunelveli District at Courtallam. I was very fortunate to observe the Liontailed Macaque on two consecutive days (2-3 March 1972) at the Manjolai Tea Estate of Bombay Burma Trading Company above Kalladaikurichi. This area is located in Thirunelveli District of Tamil Nadu State at about 8° 38′N., 77° 25′E. and about 1000 metres elevation. The region can be characterized as extensive tea and cardamom plantations interspersed with stands of relatively undisturbed forest.

I first observed a group of Nilgiri Langur (*Presbytis johni*) near the edge of a tea field. After several minutes an individual with the distinct, short, drooping tail of *Macaca silenus* was observed walking slowly along a branch. Later, when tea pickers moved into the area three *Macaca* were observed fleeing along with the group of langurs. A noteworthy difference in the behaviour of the two species was observed ; the langur moved through the canopy with long jumps accompanied by swishing of branches while the macaque walked slowly and deliberately in single file along the interior branches of the large forest trees. Only subdued vocalizations were heard from the macaque (see below), while the langur has loud call reminiscent of the whooping of the Black Howler Monkey (*Alouatta*) of Central America.

The following morning one, and perhaps two, females with young infants were observed in the same area. Judging from the size of a known age infant in the Zoo Negara, Kuala Lumpur, Malaysia, the infant at Manjolai was about two months old in early March. Sugiyama's observations (1968) indicate January is the season of birth while Prater (1971) suggests that young are seen regularly in September.

As many as six adult individuals were counted simultaneously but no doubt more were present on March 3. Throughout the observations individuals appeared and disappeared in the forest canopy over an area of several hectares, indicating that bands spread out rather widely during feeding.

Several types of feeding activities were observed. The female with infant ate fruits of unknown identity in addition to probing into the cup formed by a broken off branch. I could not determine if water or perhaps arthropods were taken from the cavity. Another adult climbed to the uppermost branches of a tall emergent tree where several dead branches projected above the surrounding canopy. Pieces up to a foot long were broken off and torn apart, presumably in search of arthropods in the rotting wood. The macaque moved lower in the tree before dismantling the branch and then moved to the upper branches again, peered into the broken stub and tore off another dead branch. A third adult was observed feeding on small red or dark brown fruits.

In addition to the perhaps fortuitous association between the langur and macaque on 2 March I did observe one aggressive response by a macaque female with infant to the close approach of an Indian Giant Squirrel (*Ratufa indica*).

Two vocalizations were heard during these observations. One, written as *ughh* or *uhhh*, carried only very short distances. This call reminded me of a warning cry of the white-faced monkey, *Cebus capucinus*, in Panama. The second call was a *cooo* or *oooo* very similar to the single *cooo* of many pigeons but of shorter duration. This call has been reported earlier but Krishnan (1971) had questioned the nature of this call as being monosyllabic or, alternatively, polysyllabic like the modulated calls of several species of *Treron*.

The most discouraging aspect of my observations is the apparent lack of subadult individuals in this group of macaques. Several factors could be responsible for this but the most likely seems to be capturing of infants for sale in the market of large cities. I am told that young Liontailed Macaques can frequently be found in the Calcutta market despite the fact that capturing them is illegal. It seems that two major factors threaten this species : (1) Habitat destruction in its restricted range, and (2) Illegal capture of infants for sale in markets.

These observations were made during the tenure of grants from the Smithsonian Tropical Research Institute, Balboa, Canal Zone and the Office of International Activities of the Smithsonian Institution, Washington, D. C. Special thanks go to Mr. J. C. Daniel and Mr. Z. Futehally of the Bombay Natural History Society for their advice, S. Poolappan for his assistance with field work and to the Bombay Burma Trading Co. and Mr. J. J. Bland for allowing me to use their facilities at Manjolai.

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2. NOTES ON THE BIRTH AND GROWTH OF A SLOW LORIS (*NYCTICEBUS COUCANG*) IN CAPTIVITY

A pregnant Slow Loris (*Nycticebus coucang*) received at the Nandankanan Biological Park (Orissa) on 1.ii.1971 from the forests of Assam, gave birth to a female young on 21.ii.1971. After delivery the mother weighed 1·4 kg.

The new born young weighed 50 gm and measured 14 cm in total length. The eyes were open at birth. The young had a coat of dense fur and numerous long glistening grey hairs were scattered throughout the body and projected far beyond the fur. These long hairs gradually disappeared when the young was about 11 weeks old. The body coat was grey throughout except the hands and limbs which were silvery white. The brown stripe on mid back was very prominent.

A single young is usually born (Prater 1971 ; Walker *et al.* 1964 ; Asdell 1964). Crandall (1965) reported that all births were of single young except the two twin births which were found dead within a day or two. The eyes of a Slow Loris young are open at birth (Crandall, loc. cit.). There is no mention of birth weight and size in the available literature.

Up to the age of seven weeks the young was seen clinging to the mother's abdomen and sucking her teat throughout the day. From the eighth week onwards and up to the age of 10 months, the young was clinging to the mother's abdomen throughout the day, partly keeping her hind quarters on the ground either in between the two limbs of the mother or over the mother's lap. Whenever attempts were made to handle or see the young during the day time, the mother with her baby curled up like a ball and twittered in annoyance. The mother cleaned the baby by licking. After sunset the young was always seen separated from the mother and was either clinging to the chainlink mesh wall or moving about in the house from the very first day. From the third day it was able to produce a feeble noise when handled and this noise immediately attracted the attention of the mother. Up to 8 weeks of age the young one was at times seen clinging to the abdomen of another female kept in the same house. Later the second female did not allow the young to cling to her, probably because of its increased body weight. The young one took bananas for the first time at the age of about one month. The mother was able to crawl along with the baby clinging to her abdomen till the baby was seven months old.

Hill (1937 b) reported that the female Slow Loris may deliberately place her baby on the ground, later picking it up but this behaviour was neither observed by Crandall (loc. cit.) nor in this Park. Crandall (loc. cit.) reported that a young born in New York Zoological Park was found clinging either to the mother or to the father and he has never seen a mother touch an infant, beyond the usual cleaning treatment with the tongue. The young remains with the mother until it is as large as the mother (Prater, loc. cit.). The young appeared to be dependent upon the mother for at least 9 months or more and a youngster was seen nursing when it was as large as the parent (Crandall, loc. cit.).

The young one reached its maximum weight of 1605 gm at the age of 44 weeks (about 10 months) on 26.xii.1971. Weekly weight growth records were taken at the end of every week and an abstract of the growth records of this animal up to the age of one year is as follows :

Date	Age in weeks	Weight in kg.
21.ii.1971	Birth	0·050
21.iii.1971	4	0·140
18.iv.1971	8	0·295
16.v.1971	12	0·480
13.vi.1971	16	0·718
11.vii.1971	20	0·920
8.viii.1971	24	1·040
5.ix.1971	28	1·222
3.x.1971	32	1·315
31.x.1971	36	1·420
28.xi.1971	40	1·530
26.xii.1971	44	1·605
23.i.1972	48	1·590
20.ii.1972	52	1·588

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3. ON SOME MELANISTIC SPECIMENS OF HOUSE RAT, *RATTUS RATTUS* (LINNAEUS) [MAMMALIA : RODENTIA : MURIDAE]

It is a well-known fact that the coat colour of rodents, specially the rats, is subject to great variations. But extreme colour variations, commonly known as albinism and melanism, are rare. The latter has been reported in several species of mammals, including rodents, but I find no record of it in *Rattus rattus* (Linnaeus). It is therefore recorded here. The note is based on a collection of five adult rats, *Rattus rattus* (Linnaeus), present in the collection of the Zoological Survey of India. Two are males (Z.S.I. Reg. No. 8366, 8374) and three females (Z.S.I. Reg. No. 8365, 8369, 8370), all collected from Calcutta in the year 1906.

The colour of the body and the tail is completely black, with no line of demarcation between the dorsal and ventral aspects. In three out of five specimens, the pinna is of lighter colour than in the other two.

All measurements are in millimetres and are taken after Ellerman (1963).

MEASUREMENTS :

External: 2 ♂♂—Head and body 181, 182 ; tail 190, 231 ; hind-foot 33, 34 ; ear 23, 24.

3 ♀♀—Head and body 145, 147, 178 ; tail 193, 195, 224 ; hind-foot 33·5, 34·5, 34·5 ; ear 19, 21, 24.

Cranial: 1 ♂—Occipitonasal 42·3 ; nasal 16·0 ; palate 22·3 ; palatal-foramina 7·6 ; diastema 12·0 ; upper tooth-row 6·3 ; bulla 7·2.

3 ♀♀—Occipitonasal 36·8, 39·0, 44·2 ; nasal 13·5, 14·0, 16·3 ; palate 19·3, 20·2, 24·0 ; palatal-foramina 6·5, 6·6, 8·9 ; diastema 10·0, 10·8, 13·0 ; upper tooth-row 6·0, 6·1, 6·8 ; bulla 6·8, 7·0, 7·7.

Different views have been put forward as to the causes of melanism. Keeler & King (1941) are of the opinion that melanism acts as a simple Mendelian recessive character. Rohe (1961) found a melanistic population of the Norway Rat (*Rattus norvegicus*), confined to underground sewers. The fact that the population was completely isolated and that the litters were all melanistic led him to believe that it was a true breeding melanistic colony. Svihla's (1956) finding that heat conservation at low temperatures does not differ in white from dark coloured rats, shows that melanism does not have any beneficial effect over non-melanistic forms. However, no opinion can be given on this aspect as my observations are based on dead specimens.

ACKNOWLEDGEMENTS

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T. P. BHATTACHARYYA

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4. THE 'DAY NEST' OF A RAT

Our house has mosquito netting in the windows. Outside one first-floor bedroom window grows a creeper which we believe is the Rangoon Creeper (*Quisqualis indica*). It has sweet pink and red flowers, fragrant in the evenings. There are some dead branches of the creeper close to the window. On these a few months ago a platform of twigs roughly 5 inches long appeared. For some days we saw no creature near it, but one day we saw a large male rat with a long tail, stretched out upon it. As we were close to the window and looked, he got a bit nervous and slowly got off the platform and hid beneath it. This rat continued to be all day long on this platform for at least a week. Then he disappeared and we wondered if he had been sick and had died. But about a week later, we noticed some activity and saw that the rat had plucked off some leafy twigs from the creeper and arranged them all around the platform and was again lying there, partially hidden from us by the leaves. As the leaves withered, he plucked off more twigs and replaced them. He lay there for over a week in this way and appeared most of the time to be sleeping. Then he again disappeared.

For many weeks we did not see him at all. Then on Wednesday, November 29, I entered the room and to my surprise the rat was there ! It was about 1 p.m. He looked fatter than before, his fur in very good condition. The platform on which he lay was in a sorry state after weeks of disuse, but on Wednesday he brought no twigs and did not repair it in any way.

When my husband returned about 6 p.m., I showed him the rat and it was still there after 10 p.m. when we went to bed, but the following morning it was not there and has not been seen since. This is its briefest visit so far.

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M. P. WALKEY

5. ALBINISM IN THE LESSER RAT-TAILED BAT, *RHINOPOMA H. HARDWICKEI* GRAY (CHIROPTERA : RHINOPOMATIDAE)

Allen (BATS 1939, p. 154) has mentioned a few cases of albinism in a few species of bats with the remarks that both albinism and melanism are rare in bats. No case of albinism came to my notice in the Indian species during examination of over four thousand specimens belonging to several species particularly from Central India. On 26th April, 1972, however, a beautiful albino adult female of the Lesser Rat-tailed Bat was collected alive along with others from a colony of about 100 individuals in caves under granite boulders near Jabalpur city. The general pelage, the wing membranes, the metacarpals, the phalanges and the ears are white or dirty white. The legs, the feet, the arms, the tail, the face, the chin and the throat are pinkish. The colour of eyes was not noted in the living specimen but in the dead specimen it is blackish. The specimen has been exhibited in the departmental museum. The specimen was kept in captivity along with other specimens for a few hours but died during night possibly because of an injury on the chest. Some parts of it were found eaten by ants during night. It kept aloof from other specimens in captivity.

Recently a friend reported that he collected an albino of *Hipposideros* sp. from a large colony in a cave in another district of Madhya Pradesh.

183/581, South Civil Lines,
Jabalpur,
June 26, 1972.

H. KHAJURIA

6. ON THE OCCURRENCE OF *GYPS FULVUS* AND *AEGYPIUS MONACHUS* IN THE GIR FOREST

The known range of the Fulvous Griffon Vulture *Gyps fulvus* (Hablizl) within the limits of the Indian subcontinent is Pakistan and northern Gujarat, although stragglers have been recorded east to western Assam, and south to Bombay (once). It has been known to be a regular winter visitor only as far south as Kutch and northern Gujarat (Sálim Ali & S. D. Ripley 1968).

However, during my field study of vulture in the Gir forest (21°6′ N., 70°46′ E.) for two years from 1970 to 1972 I found this species a common bird in the whole of the Gir forest during winter. From November to March this vulture constituted approximately five per cent of the total individuals of *Gyps* vultures observed at carcasses. The other species were the Longbilled Vulture (*Gyps indicus*) and the Indian Whitebacked Vulture (*Gyps bengalensis*).

During their stay at Gir the fulvous griffon used the cliffs of Charakio Hill which is the highest in the Gir, for roosting and resting. Continuous usage has left droppings that gave a white-washed appearance to the broad face of these cliffs which could be seen from a long distance. The name *Charakio* has been derived from the Gujarati word *charak* which means bird droppings. Fulvous griffon were also found roosting on the cliffs of the Girnar Hills, about 40 km north of the Gir, along with *Gyps indicus* which also breed there. In addition to roosting on cliffs the fulvous griffon spent nights on trees with other vultures near carcasses, to enable feeding early next morning. One such bird was caught at night with the aid of a search light and was used for captive experiments. A specimen (Reg. No. 23524) has been deposited in the bird collection of the Bombay Natural History Society.

Another species of vulture which was recorded for the first time in the Gir forest, although within its known range, is the Cinereous Vulture (*Aegypius monachus*). On 3 March 1972 at 1340 hrs a single bird came to feed off the remnants of a dead buffalo beside Hiran river at Karam-na-Dadea ness in the western Gir. It approached a King Vulture (*Torgos calvus*) which was feeding on the hard tissues of a limb, chased it aside and started pulling at the limb. This bird was similar in general appearance to the king vulture but bigger, had pinkish white legs and head, and had no lappets. Dharmakumarsinhji (1955) has observed this bird as a rare winter visitor in other parts of the Kathiawar Peninsula, namely, Bhavnagar, Dhrangadhra, and the Girnar.

ACKNOWLEDGEMENTS

The study was made possible through a Smithsonian Research Foundation Grant (SFG-O-1894) made available by the Bombay Natural History Society.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
SHAHID BHAGAT SINGH ROAD,
BOMBAY-1,
January 25, 1973.

ROBERT B. GRUBH

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7. CALCIUM INTAKE IN VULTURES OF THE GENUS *GYPS*

Vultures grouped under the genus *Gyps* were known to feed only on meat and other soft tissues of carcasses and not on bones, and therefore their mode of calcium intake, required to build up bones, had always been a mystery.

During one of my observations on vultures at Gir Forest I came across the following incident. In the western Gir, close to Sasan village, about ninety-five Whitebacked (*Gyps bengalensis*), seven Longbilled (*Gyps indicus*), four Griffon (*Gyps fulvus*), and three King (*Torgos calvus*) vultures were feeding off the skinned carcass of an ox on 23rd January 1972 at 1245 hrs. Soon a few vultures with bulging crops emerged from the squabbling flock, walked about twenty feet aside, and started picking up and swallowing pieces of old, dry bones including ribs of small animals and chopped up pieces of skull. It is a village carcass dumping site, adjacent to the forest.

To further check this up on captive birds I introduced old bone pieces into my vulture aviary. The vultures were not kept hungry. Soon after introducing bones, Longbilled, Whitebacked, and also the only Griffon I had came one by one and swallowed some bones, one of the birds dipping a piece into water before swallowing it. This observation on captive birds was also witnessed by Dr. Sálim Ali during his visit to the Gir two weeks later.

ACKNOWLEDGEMENTS

My study was sponsored by the Gir Project of Bombay Natural History Society with financial assistance through Yale University from Smithsonian Foreign Currency Programme Grant No. SFG-O-1894.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
BOMBAY,
January 1, 1973.

ROBERT B. GRUBH

8. ON THE OCCURRENCE OF GOLDENBACKED THREETOED WOODPECKER [*DINOPIUM SHORII* (VIGORS)] SOUTH OF THE HIMALAYAN RANGE

In the course of cataloguing the Society's collection, we came across a ♂ specimen of *Dinopium shorii* (Vigors) [wing 158 ; bill 34 ; tail 98] No. 10298 (collected by Major F. T. Williams) marked ' Kolatur North, S.I.R., 31st October 1897 '. Kolatur North is on the South Indian Railway not far from Madras. This is so far out of the currently accepted range of the species that we decided that though Major Williams obtained a partridge at the same place on 6th February 1898, there was some error in the labelling and that it may have been obtained in Burma where Williams had collected birds in May and June 1897.

That the labelling was not incorrect is suggested by references we have come across later. Blyth (1849) in ' The Catalogue of Birds in the Collection of Asiatic Society ', p. 56, refers to a specimen from Gumsur (Coll. Capt. McPherson) while earlier in 1845 in *Jour. Asiat. Soc.* **14** : 193, he said that this species inhabits ' the sub-Himalayan region as well as the hilly ranges of peninsular India '. Also we have Jerdon's (1862) statement in BIRDS OF INDIA (1 : 299) that he saw it on the slopes of the Nilgiris up to about 5000 ft. It may be noted that Blanford (1895) (FAUNA 3 : 63) referring to Blyth's record said : ' The reported occurrences in the Indian peninsula need confirmation ; they may have been founded on large specimens of *T. javanensis* '. Later, Stuart Baker (FAUNA 4 : 74) ignored the continental records but included Orissa in the range of *Dinopium javanense rubropygialis*. Whistler & Kinnear (*J. Bombay nat. Hist. Soc.* **37** : 294) said the last name could not refer to a bird from the southwest and called it *D. j. malabaricus*. They objected to Baker's inclusion of Orissa in its range, but though they also referred to Blyth's record, made no attempt at its identification.

The discovery of Major William's specimen prompts us to draw attention to the probability of the earlier records being correct, and to ask observers not only in the field but also those with access to other collections, to see if they can obtain corroborative evidence.

75, Abdul Rehman Street,
Bombay-3.
HUMAYUN ABDULALI

Bombay Natural History Society,
Shahid Bhagat Singh Road,
Bombay-1,
September 21, 1972.
S. A. HUSSAIN

9. DAMAGE TO MAIZE CROP BY ROSERINGED PARAKEET, *PSITTACULA KRAMERI* (SCOPOLI) IN THE PUNJAB

(*With a photograph*)

INTRODUCTION

Damage by birds to crops and fruits is not a new problem and references to their damage have been listed periodically in the last five centuries. The Roseringed Parakeet has been reported to be very destructive to crops and ripening fruits thus reducing subsequent yields. It eats by gnawing, thus wasting far more than what it actually eats (Whistler 1949; Lamba 1952; Ali 1964 and Ali & Futehally 1967). Taking into consideration its destructiveness to crops and fruits the present studies were undertaken to evaluate the extent of damage to maize crop.

MATERIAL AND METHODS

To evaluate the extent of damage to maize crop by parakeets, a plot having a total area of 1·5 acres was selected at the Punjab Agricultural University Farm, Ludhiana. The data were recorded on ten rows selected at random when the grains were set in the cobs. The damaged cobs were graded on the basis of the amount of damage done as fully damaged, $\frac{3}{4}$ damaged, $\frac{1}{2}$ damaged, $\frac{1}{4}$ damaged and $\frac{1}{8}$ damaged. Total number of fully damaged cobs were calculated by summing up the damage done to all cobs put together. The percentage of loss to the grains on cob basis was then worked out.

RESULT AND DISCUSSION

On an average, there were 60·7 cobs per line, each having 39·2 unattacked cobs. Maximum damage was observed in the form of

$\frac{1}{2}$ damaged followed by $\frac{1}{4}$ and $\frac{1}{8}$ (see photograph). The damage in the form of $\frac{3}{4}$ was the least and no cob was found fully damaged (Table 1).

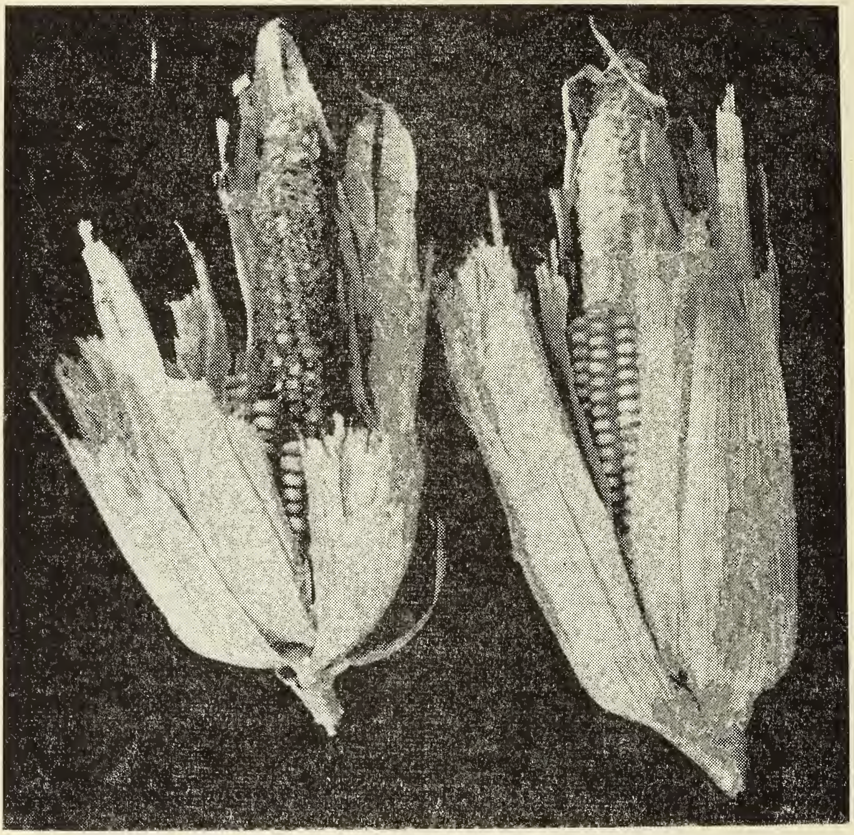

TABLE 1

INCIDENCE OF DAMAGE TO MAIZE COBS BY PARAKEET

Row No.	No. of cobs with different amount of damage $\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	Nil	Total
1	2	10	10	2	37	61
2	4	11	5	5	38	63
3	3	4	6	8	46	67
4	3	5	2	9	36	55
5	2	7	5	7	32	53
6	2	5	6	5	40	58
7	1	9	5	7	40	62
8	3	5	12	4	37	61
9	2	7	5	5	47	66
10	1	8	7	6	39	61
Average	2·3	7·1	6·3	5·8	39·2	60·7

Per cent loss to maize crop on cob basis was also worked out and is given in Table 2.

TABLE 2

PER CENT LOSS TO MAIZE BY PARAKEET

Row No.	Total No. of cobs	Loss as damaged cobs*	Per cent loss
1	61	9·2	15·1
2	63	10·4	16·5
3	67	6·7	10·1
4	55	6·4	11·5
5	53	7·1	13·4
6	58	6·1	10·5
7	62	7·4	11·8
8	61	8·2	13·2
9	66	6·9	10·4
10	61	7·2	11·9
Average			12·4

* Obtained by adding figures ¾ of column 2, ½ of column 3, ¼ of column 4 and ⅛ of column 5 of Table 1.

The data presented in Table 2 reveal that the percentage of loss to maize crop varied from 10·1 to 16·5, average being 12·4 per cent. However, Sekhon (1966) recorded on an average 20·6% loss to maize crop due to Roseringed Parakeet. His observations were based on just three rows of plants in a field. Whistler (1949) reported that it feeds bit by bit and causes damage in the gardens and fields. Ali (1964) and Ali & Futehally (1967) mentioned it to be a serious pest to the farmers and fruit growers, causing enormous losses to their standing crops and ripening fruits by gnawing at and wasting far more than it actually eats.

On the basis of the present study it may be concluded that the Roseringed Parakeet causes considerable loss to maize crop and warrants control.

ACKNOWLEDGEMENTS

We are thankful to Dr. O. S. Bindra, Professor & Head, Zoology-Entomology Department, for providing the necessary facilities to carry out these investigations.

DEPT. OF ZOOLOGY & ENTOMOLOGY,
P. A. UNIVERSITY,
LUDHIANA,
November 11, 1971.

M. RAMZAN
H. S. TOOR

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10. SIGNIFICANCE OF COMMUNAL ROOSTING IN THE COMMON MYNA [*ACRIDOTHERES TRISTIS* (LINN.)]

Although some species roost alone, in pairs or small groups, there are numerous cases in which hundreds or thousands of birds gather at a communal roosting place both during and after the breeding season. Yet till recently very little attention has been paid to explaining the function of this phenomenon in bird life. This paper summarises the result of relevant observations on the Common Myna.

The Common Myna, a black-headed vinous-brown bird about 18 cm long, is one of the most familiar species in India. It occurs in close association with man and can be found wherever man normally lives, except in high mountains, sandy desert and dense forest. It is basically an insectivorous bird but due to its association with man it is omnivorous. It roosts communally on trees in enormous flocks throughout the year.

Berhampore, a district town, is situated on the eastern side of the Bhagirathi river in the midlands of West Bengal. The eastern bank of the river is lined for about half a mile with double rows of densely growing heavily spinous babul (*Acacia arabica*) trees. A large number of tall trees like sisu (*Dalbergia sissoo*), mango (*Mangifera indica*), banyan (*Ficus benghalensis*) and peepal (*Ficus religiosa*), etc. are scattered all over the town. During the course of my study on the life of the Common Myna (Sengupta, 1969, *Proc. Zool. Soc. Calcutta* **22** : 129-137) I found that the babul trees formed the only roosting place of the Common Myna in Berhampore (area : ten square miles) although many other suitable roosting trees were abundant. As the shadow lengthened, party after party arrived from all directions and settled for the night to the accompaniment of a great deal of cacophony.

Chuchura is also a district town at a distance of 40 km away from Calcutta and is situated on the western bank of the Hooghly river. The town encompasses 6 square km and contains a large number of tall trees like banyan, mango, peepul. At Chuchura I have found only two roosting sites. The largest roosting congregation of the Common Myna is, however, on a tall banyan tree standing very close to the Chuchura

Railway Station. This railway station is situated on the outskirts of the town where the human population is very scanty. The other roosting site at Chuchura is a banyan tree standing on the bank of the Hooghly river on the eastern boundary of the town.

Sinthi is a densely populated suburb of Calcutta (population : 50,000) with large trees (coconut, banyan, mango and peepul, etc.) scattered all over the area. Here the Common Myna can be seen in abundance from dawn to dusk feeding solitarily most of the feeding time on the household refuse. But at dusk the birds leave the area to roost on trees on the outskirts of Sinthi.

Santiniketan is a university town in the district of Birbhum, West Bengal. Here I have found only one roosting site of the Common Myna; a clump of bamboo (*Bambusa* sp.) growing inside a walled graveyard at the southern boundary of the university campus (area : *c.* 6 square km).

It is therefore, clear that the preferred roosting on babul trees above all others at Berhampore, on a banyan tree on the outskirts of Chuchura, and on bamboo in a secluded graveyard at Santiniketan is because these sites are relatively undisturbed.

At Berhampore construction of a bridge over the Bhagirathi river near the rows of the babul trees was started in the early part of June 1963. Soon tents and huts were installed to house a large number of people who were connected with the construction of the bridge on the river bank close to the rows of babul trees. Work continued all through the day and night. At first I observed a sudden awakening of the Common Myna accompanied with puffing of body feathers and loud calls at intervals during the night. This behaviour was noticed till the last week of June 1963 when one evening I found three or four mynas had taken to roosting on a banyan tree about 300 metres away from the bank of the river towards the town. Within a week that banyan tree was heavily crowded with roosting mynas. Around the middle of July 1963 there were no mynas roosting either among the babul trees or on the banyan tree. I searched for their new roosting site within the town but without success. I left Berhampore in September 1967 when the bridge was still under construction. Later I learnt that the bridge was completed in the early part of 1969 and the river bank reverted to the previous undisturbed condition around July 1970. On February 10, 1971, I happened to pay a visit to Berhampore and made a trip to the Bhagirathi river. To my surprise I found a large congregation of the mynas on the rows of babul trees as before. I presume that this was due to the return of undisturbed and safe conditions on the river bank, though I was not sure if these were the same birds that had roosted on the babul trees earlier.

It appears, therefore, that selection of the roosting site in the Common Myna is dependent on protection against predators and disturbance by man. It was found in all the abovementioned places that at dawn the mynas leave their roost and disperse for foraging far and near. Several ringed mynas were found feeding 3 km away from the roost site. Mynas feed individually in populated town areas and in small parties of four to eight in the countryside yet roost communally. This habit is also found in many other birds. However, where plentiful food is available considerable congregations of mynas are found. This also happens after a moderate shower, especially in the countryside when insects come out from their hideouts. Therefore, in the Common Myna the feeding pattern (i.e. gregarious, or individual) is determined by the amount of food available in a particular area. Since the Common Myna is omnivorous its food source is not localised in patches, as for instance in granivorous birds, but is generally distributed. Hence Ward's (1965, *Ibis,* **107** : 173-214) contention that communal roosting helps birds to find patchy food source seems untenable in the case of a semi-domesticated omnivorous bird species with an unlocalized food source. Siegfried (1970, *Proc. XV Int. Ornith. Cong.*: 197) and Zahavi (1971, *Ibis,* **113** : 107-109) while discussing the communal roosting in *Ardeola ibis* and in *Motacilla a. alba* respectively have also suggested its origin in relation to food supply. Zahavi's (loc. cit.) contention that a species feeding individually cannot have communal roosting also seems untenable in a species like the Common Myna which feeds both individually and gregariously yet roosts communally. Simmon (1965, *Brit. Birds* **85** : 161-168) has also found some solitary feeders to roost communally. Therefore, the relationship between feeding habit and communal roosting as postulated by Siegfried and Zahavi (loc. cit.) cannot be applicable to all bird species especially whose food source is not patchy like the mynas. The position and pattern of the roost sites of the Common Myna suggest that communal roosting behaviour may have evolved through natural selection primarily as an antipredator adaptation leading to the survival of the species thus supporting the view expressed by Lack, 1968, THE ECOLOGICAL ADAPTATION FOR BREEDING IN BIRDS.

DEPT. OF ZOOLOGY,
VISVA-BHARATI UNIVERSITY,
SANTINIKETAN, W.B.,
May 2, 1972.

S. SENGUPTA

11. A CREST IN THE PLUMAGE OF THE SPOTTED BABBLER *PELLORNEUM RUFICEPS* SWAINSON

On 2nd May, 1971, I was on a hillside at Khandala when I came across a party of Spotted Babblers (*Pellorneum ruficeps*) some of which were singing on horizontal branches of trees. I had a close view of these birds for about ten minutes and noticed that the birds in song had crests.

During the course of rather casual conversation with Mr. Humayun Abdulali a few days later I mentioned this fact. He informed me that the standard reference works on Indian ornithology do not mention that the Spotted Babbler has a crest and he, therefore, arranged to show me specimens of *Pellorneum ruficeps* in the Society's collection.

We found that this bird does have slightly elongated feathers on the crown which can apparently be raised in life into a fairly noticeable tuft. In the prepared skin the elongated feathers have to be looked for.

C/o Mercantile Bank Ltd.,
P.O. Box No. 128,
Bombay-1,
June 22, 1971.

D. A. STAIRMAND[1]

[The occipital feathers, when they are slightly elongated, as in this species, give an impression of having a crest when the bird is excited and fluffs out the feathers on the crown. Some species of the family Pycnonotidae, e.g. Redvented Bulbul (*Pycnonotus cafer*) show this character, as also some other babblers, e.g. Browncapped Babbler, Tickell's Babbler. It is interesting to note that in such cases the birds show a definite ' cap ' on the crown—the feathers on this area being different in structure and colour from the feathers on the back—Eds.]

12. PIT VIPER [*TRIMERESURUS MACROLEPIS* (BEDDOME)] BITES AT A SOUTH INDIAN TEA ESTATE

(*With two plates*)

The Singampatti Group of tea estates lies on the eastern side of the southernmost reach of the Western Ghats. The estate and nearby forests are very interesting for many herpetological reasons. One is the abundance of certain species of snakes which are limited to a certain biotope corresponding to specific elevations and flora. *Trimeresurus*

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macrolepis is one of over a dozen Indian pit-vipers and is common in the estate and in certain forest types (wet bamboo, streamsides) over 3000 ft.

Dr. Krishnamurthy, the Medical Officer of the Singampatti Group gave me the following interesting notes concerning *T. macrolepis* (Beddome) and the incidence of bites to the workers. This snake often spends the day quietly in tea and coffee bushes, at the base of cardamom plants, ferns near streams and in passion fruit and other vines. The snake is nocturnal and will sometimes snap when poked or pulled at.

There were 18 cases of pit-viper bite in the Group estates from June 1970 to April 1971, from *Trimeresurus macrolepis* which often rest in places where pickers will put their hands, or step.

Workers invariably tie a rope tourniquet above the bite. Bites are about 60% on women (being in the majority in field work). Incidence for hand and foot bites is 50/50 ; all bites occur during the day, an average of 18 to 20 a year.

Condition on admission. Generally no tooth marks visible ; slight swelling at the alleged site of bite (which a tourniquet can cause). The limb gradually swells (hard œdema) up to shoulder or knee. The victim experiences intense burning pain at site of bite for some hours and pain in the limb for 3-4 days after the bite, after which swelling subsides. No neurological or cardiac symptoms.

Treatment. Elevation of the limb. Magsulph fomentation to the swollen area and antibiotics given. Septic bite is rare, no mortality or serious symptoms caused by these bites. No known incidence of bites from other venomous snakes at the estate.

MADRAS SNAKE PARK, R. WHITAKER
MADRAS-22,
November 13, 1972.

13. A NOTE ON 'GOLVA', A BAG NET, IN THE DAMANGANGA ESTUARY AT DAMAN

(*With a text-figure*)

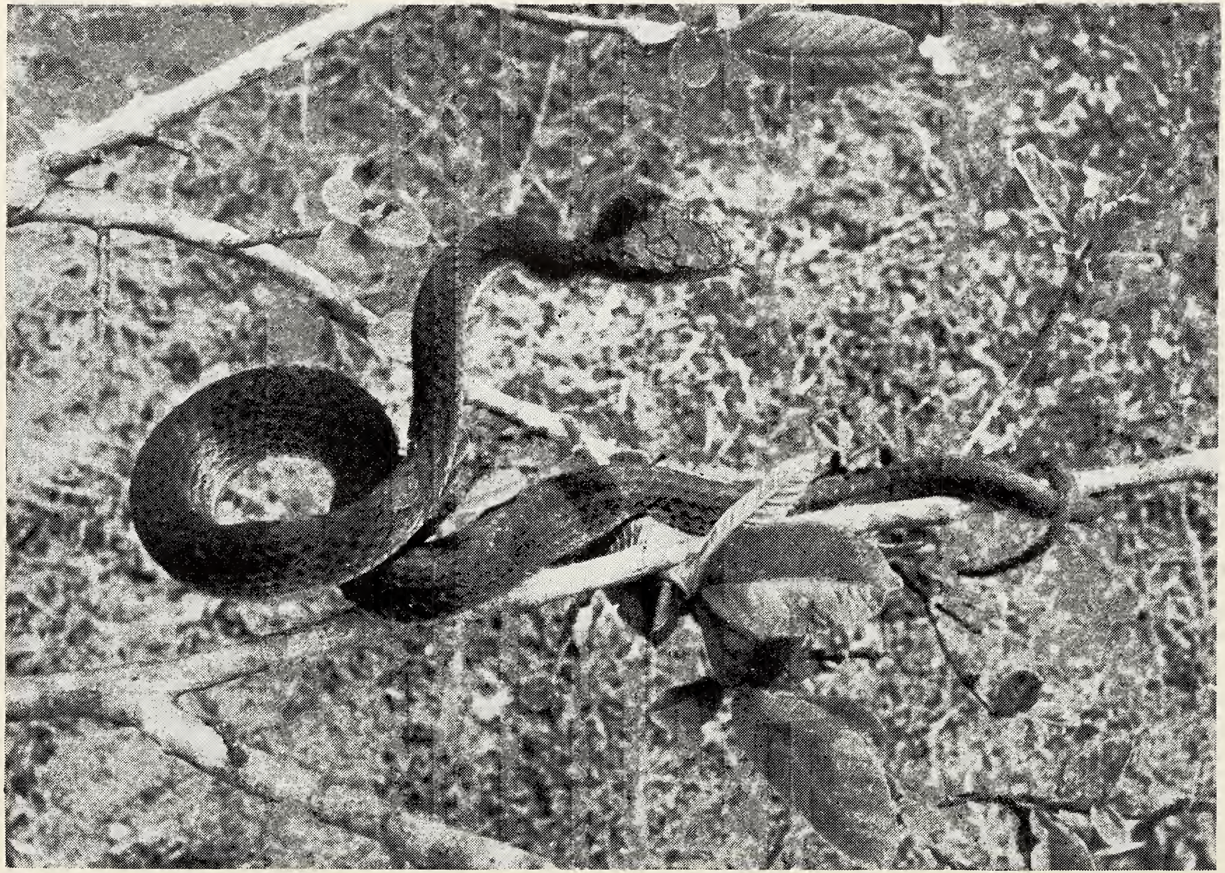
Approximately 80 per cent of the inshore fish catches at Daman are by 'Golva' nets set in the Damanganga estuary. The Damanganga is a comparatively sluggish river, generally shallow except during peak monsoon months.

'Golva' is a fusiform wide-mouthed bag net made of cotton twine, of different dimensions depending upon available operational space. It is kept in position by attaching it to two poles by its mouth in the tidal zone of the estuary for catching miscellaneous fishes. Being a fixed net,

Whitaker : Pit Viper

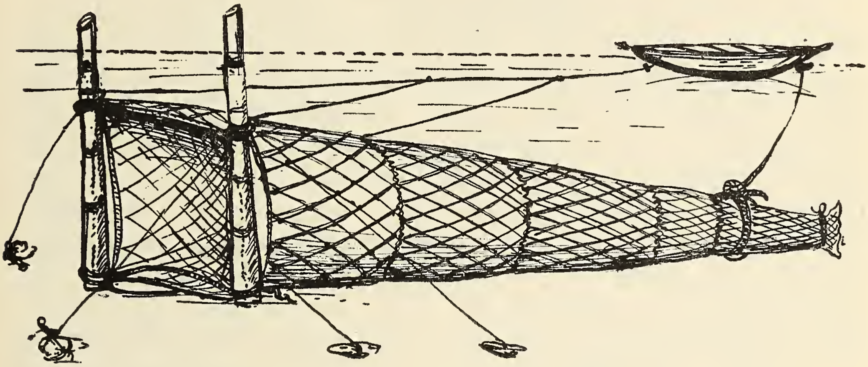
Cardamom plantation at 4,500 ft. above MSL, typical habitat of *Trimeresurus macrolepis.*

Whitaker : Pit Viper



Trimeresurus macrolepis from Manjolai, Tirunelveli Dist., Tamil Nadu.

strong tidal current is necessary for its successful operation. Principally it is a 'filter gear', which depends on the fact that many of the small fishes and crustacea carried by the tidal currents are swept into the stationary bag, from which they cannot normally escape while the water filters out.



A typical 'Golva' measures 22 metres in length, with 1300 meshes at the mouth and tapering to 150 meshes at the cod end. Lengthwise, it consists of five parts, locally called 'Galu', 'Tija', 'Bara chauthi', 'Chota chauthi' and 'Khola' with mesh sizes of 10, 7·5, 5, 2 and 1 centimetres respectively. A bunch of 4 ropes each of 5 mm diameter is tied to the mouth or the head rope all along the circumference to provide additional strength at the mouth. The bunch is tied to the head rope at an interval of 3 meshes both at upper and lower portions of the mouth while the interval is 2 meshes laterally to make them stronger for resisting the pressure of fast currents. It is set during the low tide by fixing two strong long poles on which the mouth of the net is tied at four points facing the incoming high tide making a rectangle, as shown in the figure. The rectangular mouth, at this stage, measures $9{\cdot}5 \times 6{\cdot}25$ m. The open cod end is knotted and is left adrift in the water. A 10 m long rope is loosely tied around the anterior portion of 'Khola' (Cod region) through loops by one end and the other end is attached to a floating indicator buoy. The small fishes and prawns which drift with the high tide current pass through the long net and accumulate at the cod end. The catch is periodically hauled by pulling the rope thereby lifting the 'Khola' into the canoe and untying the knot. The net is easily removed during low tides for drying by simply pulling the few strings that are fastened by special knots. Refixing of the net by the skilled fishermen before the onset of the high tide also takes about 15 to 20 minutes. A small dug-out canoe with two men can operate a number of such nets. One such net costs about Rs. 750 and remains serviceable for about five years if properly maintained by timely repairs and tanning. Generally, these nets are tanned once a month with the bark of a *Terminalia* species. The bark is boiled for about 5 to 6 hours and the nets, thoroughly washed in freshwater, are kept immersed in the decoction for 10 to 12 hours and thereafter these are dried in the sun.

Large quantities of immature fishes in the catch shows also the destructive nature of the net. It is operated almost all the year round and is admirably adapted for use in the fast tidal currents of the spring tides of each fortnight. In weak currents, the hinder part of the net bends little downwards, thereby obstructing the fishes from entering ' Khola ' region ; moreover, powerful fishes sometimes burst out of the bag, resulting in a lesser catch. Small and medium-sized *Peneus* sp., *Metapeneus* sp., *Harpodon nehereus*, *Cuilia* spp., *Pellona* spp., *Engraulis* sp., *Setipinna* spp., *Mugil* spp., *Lutianus* spp., *Therapon* spp., *Otolithus* spp., *Polynemus* sp., etc. constitute the catch. Bombay duck, *H. nehereus*, forms the bulk (60-70%) of the catch during its peak season from October to December. Generally, the catch is sold fresh locally except during the peak ' Bumla ' (*H. nehereus*) season, when the heavy catch is sundried for export to Surat, Bulsar and Bombay markets. The space for operation of ' Golva ' are leased out by the Department of Fisheries on auction for a specific period of time, and in Daman, 97 families almost exclusively earn their livelihood from the income of such nets.

ACKNOWLEDGEMENTS

The author is grateful to Dr. V. G. Jhingran, Director of the Central Inland Fisheries Research Institute, Barrackpore, and Dr. J. C. Almeida, Ex-Director of Fisheries, Goa, for their encouragement in the preparation of this note. The author is also thankful to Shri P. S. Prabhakar, Chairman of the Fisheries Co-operative Society, Daman, for his help.

SUPERINTENDENT OF FISHERIES,
DAMAN, UNION TERRITORY,
January 1, 1971.

P. DAS[1]

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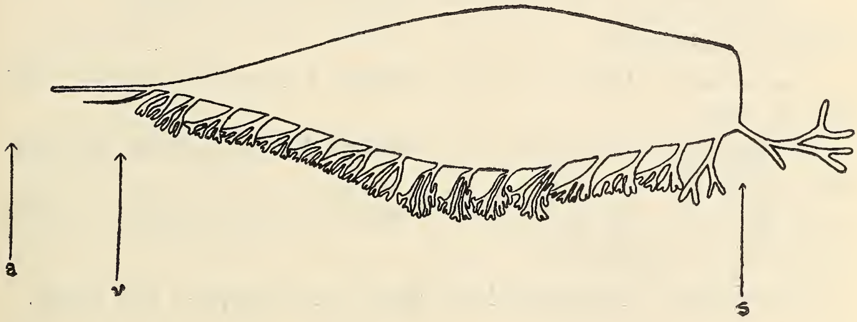
14. A GENERIC ASSESSMENT OF *CORVINA SEMILUCTUOSA* CUVIER, 1830 (PISCES : SCIAENIDAE)

(*With a text-figure*)

Corvina semiluctuosa was originally described under the genus *Corvina* by Cuvier (1830) followed by Günther (1860). Kner (1865) included the species under *Johnius* Bloch and this nomenclatural combination was recognised by all subsequent workers (Bleeker 1874 ; Fowler 1933 ; Weber & de Beaufort 1936 ; Misra 1959 ; and Chu, Lo & Wu 1963). Day (1876), however, considered *Johnius* Bloch as a subgenus of *Sciaena* Linnaeus and hence treated *semiluctuosa* under the genus *Sciaena* in the group *Johnius*. The assignment of *semiluctuosa* Cuvier to any of these genera is considered inappropriate since the species has a carrot-shaped Otolithine gas-bladder (text-figure) with 15 pairs of arborescent tubular appendages, the anterior appendages branching in the head under the skull, surrounded by the soft tissue of the head-kidney and various ligaments, blood vessels and muscles.



Text-Fig.—1. Gas-bladder of *Nibea semiluctuosa* (Cuvier) in ventral view (diagrammatic) ; appendages shown on one side only.

a. position of septum transversum.
b. position of vent.
c. position of second anal spine.

Recent workers (Trewavas 1962, 1964 ; Chu, Lo & Wu 1963 ; Sinha & Rao 1969) have emphasised the taxonomic value of the gas-bladder structure in the generic groupings and nomenclature of the Sciaenidae. This discovery of a basis for the generic classification of the Sciaenidae has completely reoriented the classification when the gas-bladder structure was ignored in favour of tropic adaptations which have proved to be only due to convergence. The species is, therefore, much more nearly related to *Nibea mitsukurii* (Jordan & Snyder), the type species of *Nibea*

Jordan & Thompson, 1911, than to the species associated with it under *Johnius*.

Corvina Cuvier has the same type-species as *Sciaena* Linnaeus, *Sciaena umbra* Linnaeus which has a gas-bladder without appendages; and *Johnius carutta* Bloch, the type of *Johnius*, has a hammer-shaped Otolithine gas-bladder. '*Corvina*' *semiluctuosa* Cuvier has no hammer-shaped expansion of the front of the gas-bladder and this, the mandibular pores and strong second anal spine place it in *Nibea*.

Nibea semiluctuosa (Cuvier, 1830) comb. nov.

Corvina semiluctuosa Cuvier, 1830, *Hist. nat. Poiss.*, **5**: 106 (Malabar, Goa & Pondicherry).

Corvina semiluctuosa Günther, 1860, *Cat. Fish. Brit. Mus.* **2**: 304; Day, 1865, *Fish Malabar*: 53.

Johnius semiluctuosa Kner, 1865, *Reise Novara Fische*: 124; Bleeker, 1874, *Verh. Akad. Wet.*, **14**: 54.

Sciaena semiluctuosa Day, 1876, *Fish. India*: 191; Day, 1889, *Fauna Brit. India. Fish.* **2**: 121.

Johnius semiluctuosa Fowler, 1933, *Bull. U.S. Nat. Mus.* (100) **12**: 404; Weber & *de* Beaufort, 1936, *Fishes Indo-Australian Archipelago* **7**: 535; Misra, 1959, *Rec. Indian Mus.* **59**: 271; Chu, Lo and Wu, 1963, *Fish. China*: 22.

Material Examined:

3 specimens, 115-295 mm S.L., Bombay, F. Day (ZSI Reg. No. 986, 987 & 1001).

2 specimens, 156-223 mm S.L., Karachi, W. D. Cumming (ZSI Reg. No. F2816/1).

1 specimen, 222 mm S.L., Ratnagiri, G. Ramakrishna, 1.6.1954 (ZSI Reg. No. F6159/2).

Distribution: India, the East Indies, the Philippines and China.

ACKNOWLEDGEMENTS

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CALCUTTA-13,
October 24, 1970.

P. K. TALWAR

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15. ON THE OCCURRENCE OF JUVENILE MACKEREL *RASTRELLIGER CANAGURTA* (CUVIER) OFF GOA COAST

Goa along with the west coast of India has a flourishing mackerel fishery solely, supported by *Rastrelliger canagurta*. Though the small-sized mackerel have been observed elsewhere yet from the Konkan Coast except for isolated records of small-sized mackerel off Karwar (Pradhan 1956) and off Ratnagiri (George & Annigiri 1960) young mackerel below 10 cm length have not, so far, been reported. I collected juvenile mackerels several times during 1964-69. The details are given in the Table. Peter (1969) has reported the occurrence of larvae from Persian Gulf, Red Sea and Bay of Bengal in Indian Ocean (22° 22′N., 60° 50′E., 16° 37′N., 41° 09′E, 18° 15′N., 87° 48′E.) from deeper waters.

The occurrence of 48-70 mm juveniles at Goa in May 1965, indicates that the spawning must have commenced much earlier than June-September as reported by Devanesan & John (1940), whereas Balakrishnan (1957) observed that breeding of mackerel commenced during March-April. George & Annigiri (1960) considered the occurrence of small sized mackerel in September as a result of spawning a few months earlier. Similar inferences can be drawn from five instances in Goa also, as recorded above. Peter (1969) has recorded occurrence of small larvae of mackerel in the Indian Ocean in October-November. This difference in the time of occurrence of larvae and juvenile in earlier reports may be due to the difference in breeding at far off places from where the larvae were obtained. Nevertheless, some observations at Goa support Balakrishnan (loc. cit.) that spawning probably takes place as early as March.

TABLE

JUVENILE OF *Rastrelliger canagurta* OFF GOA COASTS

Date	Place of collection	Size Range in mm	Mode of collection	Total No. of Juvenile observed	Depth in fathoms
28/ix/64	Panjim	60-90	Purse seine	63	12
3/x/64	Panjim	80-110	-do-	87	8
6/v/65	Calangute	48-70	Trawling	12	10
20/ix/65	Baina	105-140	Purse seine	47	10
14/x/65	Calangute	90-120	-do-	18	10
23/ix/67	Baina	80-110	-do-	35	9
1/vi/68	Baina	58-75	Trawling	18	10
1/vi/69	Calangute	55-75	-do-	9	10

The mackerel fishery in this area generally commences in September with the appearance of younger size groups varying between 160-200 mm. However, from November onwards the fishery is supported by 220-240 mm groups with mode at 230 mm during January-March. These are mostly with gonads in III stage of maturity. The largest specimen measured during this period was 290 mm in April 1968. During April and May, in all the years of observations, occasionally spent specimens were observed indicating probably termination of spawning. However, in August 1971, some stray specimens of mackerel from Rampan Catches which were in advanced stages of maturity, being V or early VI were observed on this coast. This suggests that mackerel perhaps has a prolonged breeding season with periodic spawning (more than once) during this period. There is need for further detailed investigation to confirm this observation. Plankton collections made during this period in the area do not seem to have eggs showing resemblance to mackerel eggs.

The main season of spawning of the mackerel along Konkan Coast according to Pradhan (1956), is from May to September. A subsidiary spawning season was reported on Mangalore Coast during January and February by George *et al.* (1959). Since the spawners and young mackerel have been obtained from this area at several places though in small numbers during the course of this study, it indicates that these are, stragglers from the main shoals which probably are not very far from the actual spawning ground. This could be a useful clue towards exploration of the spawning grounds of mackerel. The occurrence of small-sized mackerel from May-September adds strength to the contention that the Indian mackerel may have a prolonged spawning season. No doubt, the occurrence of juveniles and even adult with spent gonads in an area does not always reveal correct picture about spawning grounds and spawning season yet the probability of these grounds being close to the area of occurrence cannot be completely ruled out. Prolonged breeding season with periodic spawning during the season (more than once) indicates the possibility of different races coming into commercial fishery with gonad in different stages of maturity.

Food of juvenile mackerel :

The food of the small-sized mackerels up to 95 mm size as revealed in the gut contents consisted of diatoms, dinophysids, and a few copepods and protozoa. The gut contents of mackerel, between 95-105 mm was mainly post-larvae of fishes, and crustacean larvae, with negligible phytoplanktonic organisms. The feeding intensity was appreciably high. The food of size groups constituting the commercial fishery between 170-230 mm was mainly diatoms like *Consinodiscus*, *Rhizosolenia*, *Biddulphia*, *Planktoneilla*, *Pluerosigma* and *Chaetoceros* sp. The zooplankton constituents of mackerel food, along this coast are forms like calanids, copepods, cladocera and advanced stages of crustacean, and molluscan larvae, tintinnids and dinoflagellates. The feeding intensity of mackerel is generally high from September to March but moderate from April to June. During April-June period fish scales were often found in the stomachs of mackerel caught by purse seines.

ACKNOWLEDGEMENTS

I wish to express my thanks to Dr. M. S. Prabhu, formerly Director of Fisheries, Panjim, for his guidance during the course of this work. I am also grateful to Dr. P. V. Dehadrai, Scientist, National Institute of Oceanography, Panjim, for going through the manuscript.

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16. THE SOCIAL SPIDER, *STEGODYPHUS SARASINORUM* KARSCH. FEEDING ON THE LEMON BUTTERFLY, *PAPILIO DEMOLEUS* LINN.

The senior author during a visit to Hatta village in Parbhani District found the webs of the Social Spider holding the dead bodies of the adult lemon butterflies *Papilio demoleus* Linn. on orange trees in a citrus garden. Some of the webbed branches were collected and brought to the laboratory where the webs were kept under a bell jar with a piece of cotton swab dipped in chloroform and spiders that emerged out of the web and died were counted and preserved in 70% alcohol. The webs were then cut and the butterflies separated and counted. It was observed that the bigger webs on an average had 58 spiders and the smaller webs 26 spiders, living almost in the heart of the web. On an average 18 and 8 adult lemon butterflies were collected from the bigger and small webs respectively. The abdomen of the butterflies were completely eaten.

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April 7, 1972.

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17. A NOTE ON *IDIOSCOPUS CLYPEALIS* (LETH.) (HEMIPTERA : CICADELLIDAE)

During local faunistic surveys of Poona and its surrounding areas I collected some Jassids on mango leaves from Nasrapur, about 40 km east of Poona. They were studied at the laboratory to find the nature and distribution of clypeal spots in both the sexes. Distant (1907) while examining the species observed ' face immaculate or with the small black median spots '. Capriles (1964) also made a similar observation, but while classifying the species, described the presence of the spots in the female. I, therefore made three collections in June, July and August 1968, in order to study the exact nature of the distribution of the spots in both of the sexes and the results are tabulated below :

Idioscopus clypealis (Leth.)

Date	♀♀		♂♂	
	No. of specimens with clypeal spots	No. of specimens without spots	No. of specimens with clypeal spots	No. of specimens without spots
21-vi-68	114	1	4	82
20-vii-68	109	—	6	85
22-viii-68	99	—	8	93

It is clear from the above data that the males also possess these spots although their number and ratio is very small when compared with those of the females. Almost all the females possess the spots.

ACKNOWLEDGEMENT

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ZOOLOGICAL SURVEY OF INDIA,
WESTERN REGIONAL STATION,
POONA,
March 21, 1970.

K. RAMACHANDRA RAO

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18. SEASONAL CHANGES IN THE POPULATION OF EPILACHNA BEETLE *HENOSEPILACHNA SPARSA* HERBST. (COLEOPTERA : COCCINELLIDAE)

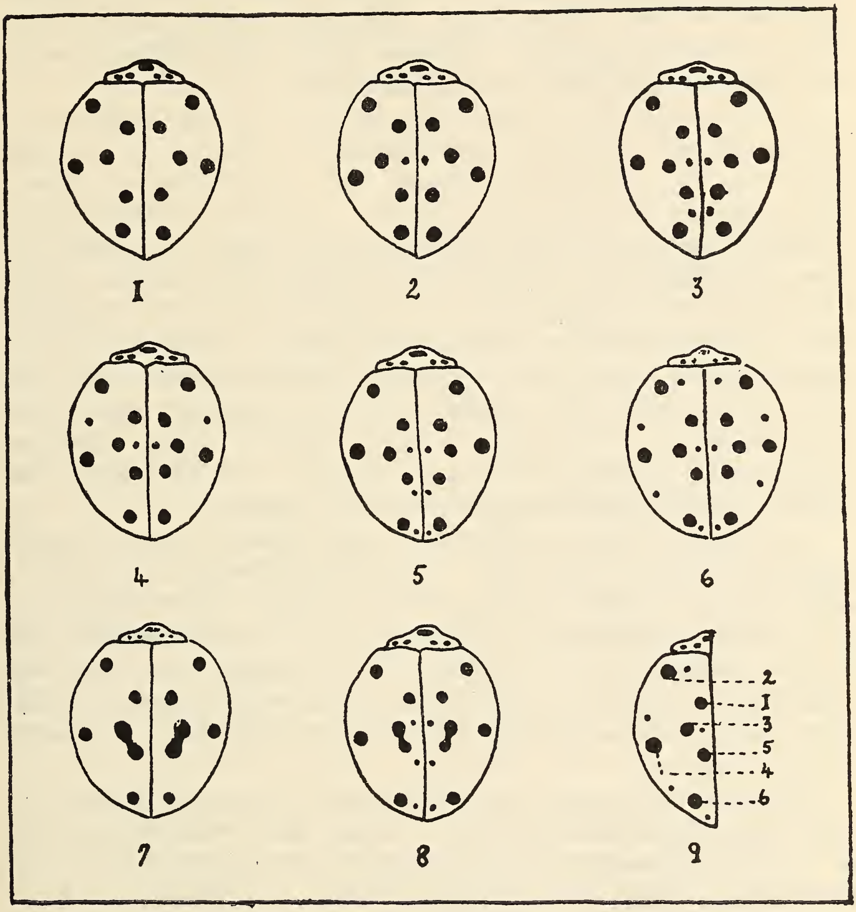
(*With nine text-figures*)

Observations have been made by the authors on the seasonal changes in the population of Epilachna beetles, *Henosepilachna sparsa* Herbst. in the field and laboratory. The beetles were reared in the laboratory in rearing cages specially designed by Edona and Soans. Outside the beetles thrive on *Datura fastuosa* in the Malabar Christian College compound. Seasonal changes affect the population both inside the laboratory and outside, but outside the seasonal changes are more pronounced.

The presence of Epilachna beetles can be best determined by examining the leaves of *Datura fastuosa.* The leaves are seen eaten up in irregular patches with the thin upper cuticle of the leaf entirely or partly covering those areas. When the underside of these injured leaves is examined, one is likely to find epilachna beetles in one stage of development or the other.

The beetle population reaches its highest numerical strength about the middle of October and continues till the end of November. The favourable climatic conditions which succeed the rainy season seem to be responsible for this increase. Beetles breed rapidly and feed voraciously in the field. Both the larvae and adults feed on the under surface of the leaves skeletonizing them and producing a new crop of adults. Dry yellow leaves with practically all the tissue eaten and with a fine net work alone remaining indicates heavy infestation.

In the laboratory also beetles multiply rapidly during these days. Specimens with different elytral maculation appear during this season. The basic elytral maculation consists of 6 black spots always present on each elytron arranged as in fig. 1; but these may be augmented by the presence of 1-5 black non-persistent spots variably present (figures 2-6). Both persistent and non-persistent spots are variable in size, the former being usually bigger than the latter. Occasionally some spots may coalesce.



Henosepilachna sparsa Herbst.: Figs. 1-9

1. Basic elytral maculation of 6 black spots. 2-6. spot patterns of elytra showing presence of 1-5 non-persistent spots on each elytron. 7-8. coalescence of spots. 9. left elytron, persistent spots numbered 1-6.

From the middle of December throughout January a slight reduction in the population is noticed. This becomes more pronounced in February and in March. By this time only six-spotted beetles are seen and occasionally7-spotted ones. By April the reduction in the population reaches its climax. Of the insects present only few lay eggs and there is considerable reduction in the number of eggs in each batch. Due to the heat and dry air most of the eggs, larvae, pupae and adults are killed. Mortality is highest in the first and the second instars. The eggs remain dead and dry on the plants ; the larvae and adults are killed and fall to the ground ; while the pupae are left dark brown and black to dry up on the plants. These conditions are common both in the field and the laboratory. Occasionally a few beetles emerge one at a time during late March and April. But none of these develop normal feeding habits and therefore have a shorter span of life.

By the second week of May when the rains start the temperature is slightly reduced, the beetle population begins to improve in the cages and in the field. Mortality is reduced. More insects begin to appear. The population increases in June and July. When the rainfall increases in the last week of July and at the beginning of August, the normal activities of the beetles are curtailed but rain storms seldom continue without intermission for very long and the temperature is always high enough for activity to be resumed as soon as the rain stops. In August there is a slight reduction in population because the torrential showers wash away the eggs and larvae from exposed places. In September again there is an increase in the population, which continues till the middle of December but reaches its climax in November. By September adult beetles of different elytral maculation begin to appear.

Variations in number among these beetles therefore seem to depend largely on weather conditions. The population increases in numbers and the beetle becomes a major pest in the years of normal temperature and rainfall, but decreases in numbers in years of high temperature and droughts, especially when these periods are prolonged. Thus there was greater increase in numbers in November 1968, when the climatic conditions were more favourable than in November 1969 which was a period of inclement weather.

There were a few places where the mortality was not very high even under generally adverse conditions. Because they contained vigorously growing Datura plants which were irrigated and thus protected from unfavourable climate. However inclement climatic conditions may be, it does not seem likely that total eradication of the beetle will occur. The insect either persists on Datura throughout the year or is only temporarily held in check by unfavourable weather conditions.

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December 27, 1969.

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19. THE PROCESS OF MOULTING AND THE NUMBER OF INSTARS IN THE TIGER BEETLE, *CICINDELA CANCELLATA* DEJ. (COLEOPTERA : CICINDELIDAE)

(*With a text-figure*)

Cicindela cancellata Dej. is a tiger beetle which is widely distributed in India. Its larvae live inside burrows in the soil and therefore it is very difficult to observe all the details of its life-history under natural environmental conditions. The authors have been rearing this species in the laboratory in specially designed glass rearing jars. As a few of the larvae excavate their burrows accidentally, along the wall of the rearing jar, it is possible to observe through the glass wall the process of moulting in the larva inside the burrow. This paper gives an account of the process of moulting and also the result of an indirect investigation into the number of larval instars in this beetle by the application of Dyar's Law.

The process of moulting. The larva, after a period of active feeding and just before the moult, blocks the opening of the burrow with sand, stops feeding, settles down at the bottom of the burrow and becomes inactive. At this stage, the abdomen of the larva, which at other times is light brown or grey in colour, becomes yellowish. The larva occasionally wriggles its body rapidly in an undulating fashion. Frequently, the body is suddenly bent ventralwards in a snapping manner.

Moulting takes place during the night. As a result of the characteristic movements of the body and other internal factors, the larval cuticle splits along the ecdysial lines which are present on the head and the thorax. On the head, splitting of cuticle takes place along the short coronal suture and the arms of the frontal suture which are relatively long and slightly wavy, diverging widely and terminating anteriorly at the dorsal edges of the antennal sockets. In the thorax, the cuticle splits along the mid-dorsal line of weakness or ecdysial line. The pattern of ecdysial splitting of the cuticle is clearly seen in the exuviae collected from the burrows.

The number of instars.—Dyar (1890)[1] stated that in lepidopteran larvae, the width of the head capsule increases in a regular geometric progression through successive instars, by a ratio of about 1·4. This principle which is known as Dyar's law, has been used successfully to determine the number of larval instars in some insects.

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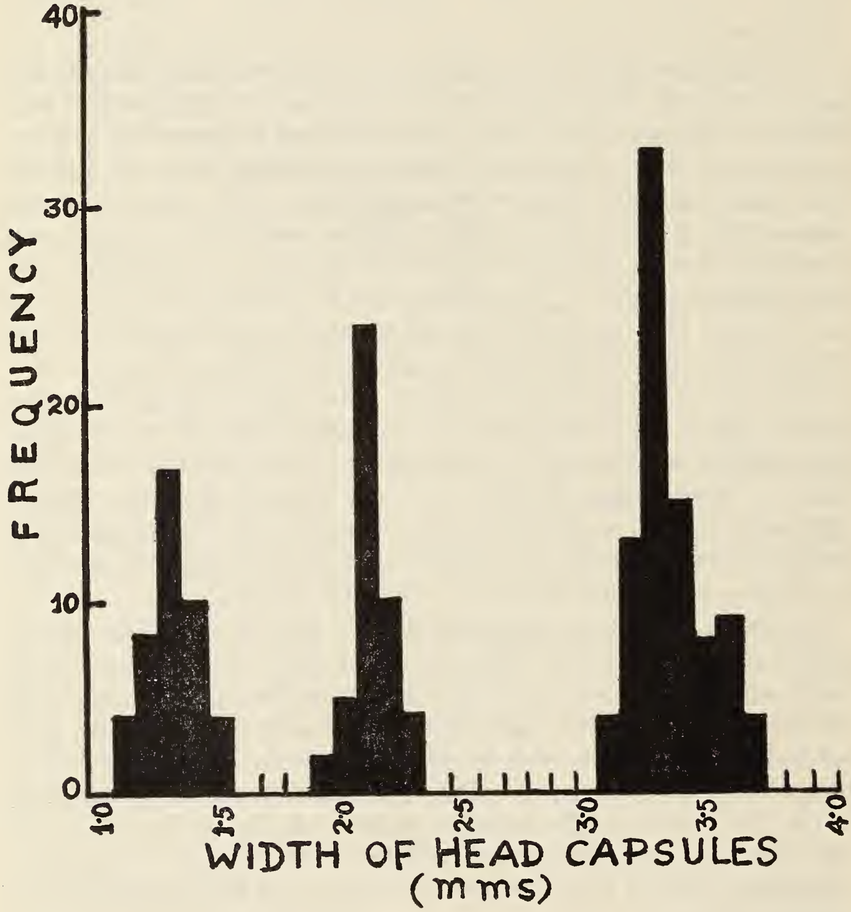
[1] DYAR, H. G. (1890) : The number of moults of Lepidopterous larvae. *Psyche.* 5 : 420-422.

A large number of larvae of *Cicindela cancellata* in the various stages of growth, were collected from the field and from the rearing jars in the laboratory. The measurements of the width of their head capsules were recorded and the frequency distribution of the various values was studied. The text-figure gives the results in the form of an histogram.



Histogram of the width of head capsules of the larvae of *Cicindela cancellata*.

The histogram clearly shows that the width of head capsules fall under three distinct and discontinuous classes, indicating that there are three larval instars in the life cycle of *Cicindela cancellata*. The mean width of head capsules of the three instars are, 1·31, 2·12, and 3·36 millimetres respectively. The growth ratio between the first and second instar is 1·63 and that between the second and the final instar is 1·59. It is seen that the growth ratio between successive instars is approximately constant.

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20. NEW RECORDS OF HYMENOPTEROUS PARASITES OF PEA LEAFMINER *PHYTOMYZA ATRICORNIS* MEIGEN (DIPTERA : AGROMYZIDAE)

The pea leafminer *Phytomyza atricornis* Meigen is the most common and widespread leafminer throughout the world. The larva of this pest is polyphagus and attacks a large number of plants belonging to several natural orders. According to Trehan & Sehgal (1963), the larva feeds indiscriminately on pallisade and spongy mesenchymatous tissues but never consumes the entire tissues between the upper and lower epidermis and the endodermal cells containing starch are largely avoided. Ahmad & Gupta (1941), while studying the biology of this pest on pea, reared an Eulophid, *Solenotus* sp. from its larval stages. Narayanan *et al.* (1956) reared an ectoparasite *Solenotus* sp., an endoparasite, *Rhopalotus* sp. and an unidentified braconid on the larval stages of this host fly. Only recently Odak *et al.* (1968) have recorded *Opius* sp. (Braconidae) and *Neochrysocharis* sp. (Eulophidae) as parasites of *P. atricornis* from Gwalior (India). The present study was, thererfore, undertaken to investigate parasites of this leafminer in the Ranchi area and leaves of pea (*Pisum sativum* Linn.) were collected. The following six hymenopterous insects emerged from the leafmines.

1. *Chrysocharis* sp. (Eulophidae)

Thompson (1943, 1954) has recorded *Chrysocharis* sp., *C. elongatus* and *C. syma* from New Zealand, Yugoslavia and England respectively, as parasites of this leafminer.

2. *Tetrastichus* sp. (Eulophidae).
3. *Cirrospilus* sp. (Eulophidae).
4. *Opius* sp. ? *phaseoli* Fischer (Braconidae).
5. *Opius* sp. ? *lantanae* Bridw. (Braconidae).
6. *Sphegigaster* sp. (Pteromalidae).

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21. CONTRIBUTION TO THE STUDY OF AQUATIC BEETLES —14. *COPELATUS NEELUMAE* SP. NOV. (DYTISCIDAE) FROM INDIA

(*With a text-figure*)

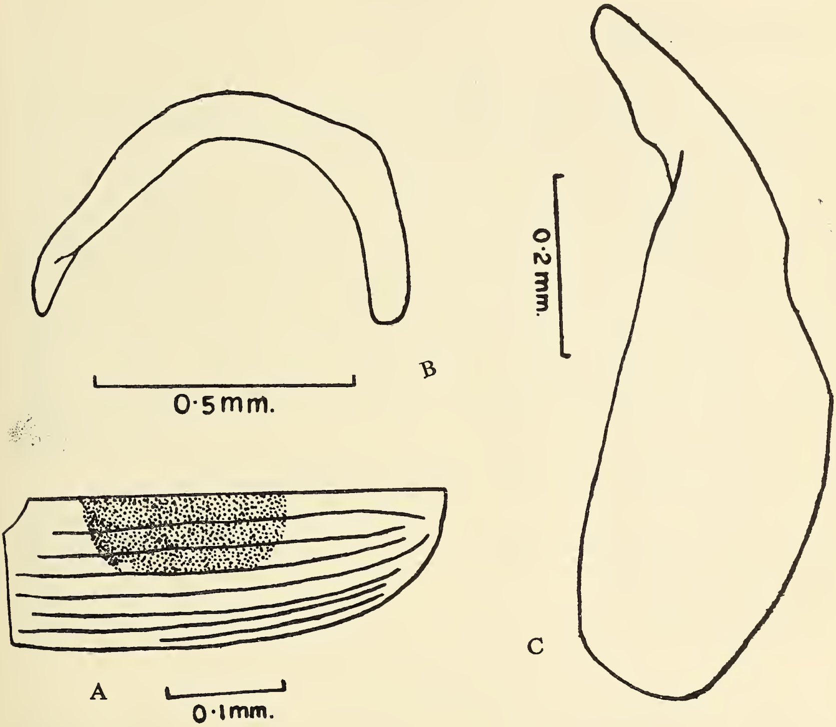
Copelatus neelumae sp. nov.

Holotype—♂, Tamilnadu: Ottokovil, Tiruchirapally District, from a tank near Uppada river, 13.iii.1971, K. V. Lakshminarayana coll. In the National Collections, Zoological Survey of India, Calcutta. Z.S.I. Regd. No. $\frac{6052}{\text{H4A}}$.

Length 5·4 mm. Breadth 2·8 mm.

Head rufo-ferruginous, slightly paler anteriorly; punctation on the disc quite dense, separated by its own diameter, irregular, more sparse anteriorly and towards the sides; surface distinctly microreticulate.

Pronotum rufo-ferruginous with sides slightly paler ; anterior row of punctures quite regular ; punctation of surface finer and less dense than on the head, on the disc separated by 2-3 times its own diameter ; surface micro-reticulate as on the head.



TEXT-FIGURE. *Copelatus neelumae* sp. nov., A—left elytron ; B—lateral view of penis ; C—protibiae in male. All from holotype specimen.

Elytra (Text-fig. A) pale testaceous with irregular rufo-ferruginous spots between the suture and third striae, but neither touching the base nor the apical one-third of the elytra. Elytral striae disposed as under.—Striae 1, 2 and 5 abridged at base (1 more than the other two), while striae 3, 4 and 6 commence from the base ; striae 1 more abridged at base than striae 2 and striae 2 less abridged at base then striae 5 ; submarginal striae extending a little beyond the middle anteriorly and terminating almost near the apex of striae 6. Striae 6 shorter than 5 at apex, striae 5 shorter than 4 at apex, striae 4 and 1 terminate beyond apex of 3 and 2, nearly enclosing both of them. Punctation and reticulation as on pronotum but less impressed.

Ventral side pale testaceous ; metacoxae and 3 visible abdominal sternites with short, oblique, profound strioles, those on the abdominal sternites a little longer than on metacoxae. Male protibiae (Text-fig. C) enlarged towards apex, distinctly curved and notched at base; basal three segments of protarsi and mesotarsi moderately enlarged; penis (Text-fig. B) slender, curved, asymmetrical from dorsal surface (rather twisted).

Female—unknown.

Remarks: This species belongs to the *irinus* group, Guignot (1961) and comes close to *C. bangalorensis* Vazirani, *C. indicus* Sharp and *C. freudei* Guignot; in coloration and elytral markings. It differs from all the above species in having elytral striae 1, 2 and 5 abridged at base as against elytral striae 1 abridged at base. In the shape of penis, which is without a dorsal lobe, it comes close to *C. indicus* and *C. freudei*, while in size it is larger than both of them. The specimen under report is freshly emerged, therefore the coloration described above is to be viewed accordingly. In mature specimens the coloration will be darker, but the basic pattern of markings will remain the same. The penis had protruded and had separated and was glued to the card along with the specimen. Vazirani (1970) has given key to the species known from India and has figured the genitalia of the other species mentioned above.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA-16,
November 13, 1972.

T. G. VAZIRANI

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22. *QUISQUALIS INDICA* LINN. AND *DODONEA VISCOSA* LINN. AS NEW HOSTS OF CASTOR SEMILOOPER, *ACHOEA JANATA* LINN.

Castor semilooper, *Achoea janata* L. (Lepidoptera, Noctuidae) is a serious pest of Castor (*Ricinus communis*), guava fruits (*Psidium guajava*) (Srivastava 1960) and citrus fruits (Ayyar 1940 and Rakshpal 1945) in orchards, Pruthi & Mani (1945) reported rose (*Rosa indica*), pomegranate (*Punica granatum*) and *Euphorbia pilulifera* as the alternate hosts while Khan (1946) further included 'Kachnar' (*Bauhinia variegata*), 'Ber'

(*Zizyphus jujuba*), 'Dudhi' (*Euphorbia hirta*) and banyan (*Ficus bengalensis*) as the alternate hosts. The larvae were also observed, in forests, to feed on 'Babool' (*Acacia arabica*) and *Albizzia amara* by Bhasin & Roonwal (1954). The present report records the feeding of *A. janata* larvae on two additional hosts, namely the hedge plant *Dodonea viscosa* (Family Sapindaceae) and the ornamental Rangoon creeper, *Quisqualis indica* (Family Combretaceae). Both these plants are important garden ornamentals. So far, we have observed feeding of this pest in laboratory on more than a dozen hosts in varying degrees of intensity but observations made during the last two years at Jobner, Udaipur and Jaipur revealed that the two plants reported here suffer substantial damage by this insect from July onwards. Further, both *Quisqualis* and *Dodonea* were observed to be attacked in the field simultaneous to the occurrence of the insect on castor within a distance of 7 metres and 13 metres respectively. This showed that even in the presence of the primary host the gravid female moths oviposited on these garden plants indicating a potential preference of the insect to these plants. Detailed studies on the host preference of this insect are underway.

DEPARTMENT OF ENTOMOLOGY,
AGRICULTURAL EXPERIMENT STATION,
UNIVERSITY OF UDAIPUR,
UDAIPUR,
September 12, 1970.

V. S. KAVADIA
S. K. VERMA

REFERENCES

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23. THE OCCURRENCE OF THE COMMON PALMFLY (*ELYMNIAS HYPERMNESTRA CAUDATA* BUTLER) NEAR BOMBAY

On 27th September 1972 I captured a female of the Common Palmfly (*Elymnias hypermnestra caudata* Butler) at Kihim, Kolaba District, a few miles south of Bombay. This appears to be an extension of its range as there are no definite records of this butterfly from anywhere near Bombay.

According to Wynter-Blyth (BUTTERFLIES OF THE INDIAN REGION) the species may be found ' at low elevations in suitable localities in the peninsula as far north as Madhya Pradesh ', but till now *E. h. caudata* has not been apparently recorded north of Karwar (N. Kanara) which is the northernmost point from where a specimen in the Society's collection has been obtained.

The specimen, now in the Society's collection, was seen settled near the ground on a bush along the seashore. As the wings were rather tattered it may have been carried northwards by the monsoon winds.

I am grateful to the Society for the use of their equipment and in particular to Mr. N. T. Nadkerny who kindly confirmed the identification of the specimen and supplied some of the references.

SALMAN ABDULALI

SUNBEAM,
PERRY CROSS ROAD,
BANDRA, BOMBAY-50,
November 24, 1972.

24. OCCURRENCE OF THE GENUS *CONCHYLIURUS* BOCQUET & STOCK (CYCLOPOIDA-CLAUSIDIIDAE) IN RATNAGIRI

While studying the biology of *Meretrix meretrix* L., I came across a number of semi-parasitic copepods in the mantle cavity of the clam. These copepods belonged to two different species of the genus *Conchyliurus*. This genus was created by Bocquet & Stock (1957) with *C. solensis* as the type species. From Indian waters, the genus *Conchyliurus* was first recorded by Reddiah (1960), who described a new species *C. maximus* Reddiah from *Sanguinolaria* (*Soletellina*) *diphos* (Gmelin) from Portonovo. In the following year, Reddiah (1961) described two more new species, *C. bombasticus* Reddiah and *C. fragilis* Reddiah from *Meretrix meretrix* (L.) from Portonovo. A detailed examination of the local specimens revealed that they belonged to the last two species described by Reddiah (op. cit.) from *M. meretrix* (L.). This is thus the first record of the genus *Conchyliurus* from the West Coast of India.

So far about nine species have been described under this genus. Considering the richness of the molluscan fauna of India, more species are likely to be discovered in future. It is therefore, considered, that the distribution (Table) of all known species of this genus, together with their type hosts and localities, would be useful for future workers on this group.

TABLE

Species	Host	Locality
Conchyliurus solensis Bocquet & Stock (1957)	*Solen marginatus* Don*	Near Roscoff, France**
C. cardii Gooding (1957)	*Cardium echinatum* L.*	Near Plymouth, England
*C. cardii cardii**** Gooding (1957)	*Solen marginatus* Don, *Cardium echinatum* L.,* *Meretrix chione* (L.)	France
C. cardii tapetis Bocquet & Stock (1958)	*Tapes decassatus* (L.),* *Tapes pullastra* (Montagu), *Tapes aurens* (Gmelin)	France**
C. torosus Humes & Cressey (1958)	*Mactra glabrata* L.,* *Mactra largillerti* Phillippi	Free Town, Sierra Leone,** West Africa
C. lobatus Humes & Cressey (1958)	*Cardita ajar* Bruguiere*	Free Town, Sierra Leone,* West Africa
C. maximus Reddiah (1960)	*Sanguinolaria* (*Soletellina*) *diphos* (Gmelin),*	Near Portonovo,** east coast of India
C. bombasticus Reddiah (1961)	*Meretrix meretrix* (L.)* *Meretrix casta* Deshayes	Near Portonovo,** east coast of India Ratnagiri, west coast of India
C. fragilis Reddiah (1961)	*Meretrix meretrix* (L.)*, *Meretrix casta* Deshayes	Near Portonovo,** east coast of India, Ratnagiri, west coast of India.

* Type host, ** Type locality, *** Bocquet & Stock (1958) downgraded Gooding's species *C. cardii* into a subspecies and referred to it as *C. cardii cardii* Gooding.

I wish to express my sincere thanks to Dr. K. Reddiah, Officer-in-Charge, Eastern Regional Station, Zoological Survey of India, Kench's Trace, Shillong (Assam) for his help in identification of the species and loan of some important references. I am also grateful to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State and Dr. H. G. Kewalramani, Senior Scientific Officer, for their helpful criticism.

MARINE BIOLOGICAL RESEARCH
RATNAGIRI, STATION,
March 4, 1970.

M. R. RANADE

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25. ON THE OCCURRENCE OF *CUSCUTA SANTAPAUI* BANERJI & DAS IN WESTERN HIMALAYAS

While working on the flora of Kinnaur district, Himachal Pradesh, the author came across a few plants of this species growing along the banks of Tangling khud nala at Shongtong and at Kilba. The species was first described by Banerji & Das (loc. cit.) based on materials collected from East Nepal and Assam. Vaid & Naithani (loc. cit.) recently reported its occurrence in Chandanwari (Kashmir) and in New Forest (Dehra Dun). The present report from Shongtong and Kilba, besides being additional information about its distribution in the country, helps to some extent also in bridging the vast discontinuity in its distribution from Assam and East Nepal in the east to Chandanwari at the northwestern limit of the Himalayas. A careful search in the field and n herbaria may provide more data of its distribution elsewhere in the

Himalayas. The data on the distribution available now indicate that the plant has a wide distribution, probably occurring over the entire range of the Himalayas.

This species is often confused with *C. reflexa* Roxb. which it resembles closely. The characters which enable one to distinguish the two species have been dealt with in detail by Banerji & Das (loc. cit.) and Vaid & Naithani (loc. cit.). The figures of the floral parts of the two species in the plate in Banerji & Das (loc. cit. 88) are also very helpful in distinguishing the present species from *C. reflexa* Roxb.

The nomenclature of the plant is as follows :

Cuscuta santapaui Banerji & Das in *Journ. Arn. Arb.* **46**(1) : 87, 1965 ; Vaid & Naithani in *Ind. For.* **97**(8) : 467-468, 1971.

The plant is usually seen in open situations on the margins of forests. The whole plant is creamy white or hay-coloured when young and turns pale reddish-brown later. The fruits are creamy white when mature ; they also turn pale reddish-brown on ageing. The stem and fruits are dotted with brownish-black spots which are clearly visible even in dried herbarium material.

Specimens examined : HIMACHAL PRADESH : Shongtong, on the banks of Tangling khud nala, alt. ± 1970 m, 6th October 1971, *K. P. Janardhanan* 46486, in fls. & frts., parasitic on *Prunus persica* (Linn.) Stokes ; Kilba, hillslope above the Forest Rest House, alt. ± 2100 m, 10th October 1971, *K. P. Janardhanan* 46577, in fls. & frts., parasitic on *Desmodium tiliaefolium* G. Don ; Sangla, alt. ± 2700 m, 25th September 1964, *N. C. Nair* 34272, in fls. & frts., parasitic on *Desmodium tiliaefolium* G. Don (BSD).

ACKNOWLEDGEMENT

I am thankful to Dr. M. L. Banerji, Reader in Botany, University of Kalyani, Kalyani, for confirming the identity of the above specimens.

BOTANICAL SURVEY OF INDIA,
DEHRA DUN,
September 18, 1972.

K. P. JANARDHANAN

26. PLANT RECORDS FOR MAHARASHTRA STATE FROM CHANDRAPUR DISTRICT

During botanical explorations of Chandrapur district of Maharashtra State, some interesting plants new to the state were recorded.

In this note the correct nomenclature, diagnostic characters, details of collection and critical notes are given. All the specimens cited here are deposited in the herbarium of the Western Circle, Botanical Survey of India, Poona (*BSI*).

RUBIACEAE

Hedyotis coerulea Wt. & Arn. Prodr. 412, 1834 ; Fl. Brit. India **3** : 60, 1880.

An erect herb. *Leaves* linear, sessile, bristle pointed. *Flowers* greenish blue. *Capsules* nearly globose. *Fls.* & *frts.* : August-December. Rare, on sandy soil. Pamburna, *Malhotra* 123790 ; Wamanpalli, *Malhotra* 123806.

Gamble (1921) records this plant from eastern coast (Rampa in Ganjam, Nellore to Tanjore) and also South Kanara on West coast. The present record of the species from Chandrapur district (Maharashtra) extends its distribution further north.

CONVOLVULACEAE

Ipomoea sindica Stapf in Kew Bull. 346, 1894; Rolla Rao & Kanodia *in* Ann. Arid Zone **2**(1) : 38, 1963.

A trailing herb. *Leaves* oblong, hastate, acute. *Flowers* light pink. *Capsule* glabrous ; seeds velvety. *Fls. & frts.* : August-October. Rare. On coarse soil. Taroba National Park, *Malhotra* 122594 & 122787.

This plant has been earlier recorded from drier parts of Kutch (Gujarat State) and also from Jodhpur division of Rajasthan. Therefore, the occurrence of this plant in such dry deciduous forests of Chandrapur district (Maharashtra) indicates the possibility of locating this taxon in the surrounding deciduous forests and hilly tracts of central India.

EUPHORBIACEAE

Acalypha lanceolata Willd. Sp. Pl. **4** : 524, 1805 ; *A. fallax* Muell-Arg. *in* Linnaea **34** : 43, 1865 ; Hook. f. Fl. Brit. India **5** : 416, 1887.

Annual slender herb. *Leaves* ovate-lanceolate cuneate at the base. *Flowers* pale greenish. *Capsules* longer than the bracts, hispid. *Fls. & frts.* : August-October. Not common, on coarse soil. Taroba National Park, *Malhotra* 122596.

The present record is interesting, as it links up the earlier known distribution in southern India, namely N. Circars, Deccan and Carnatic to S. Travancore (Gamble 1925) and Central Bengal in the east (Prain 1903). It is quite possible the species might occur in the deciduous forests of Bihar and Orissa.

POACEAE

Arthraxon echinatus (Nees) Hochst. *in* Flora **39** : 188, 1856 ; Bor, Grass. Burma, Ceylon, India and Pak. 99, 1960 ; *A. spathaceus* Hook f. *in* Fl. Brit. India **7** : 145, 1896.

Annual grass. *Spikelets* greenish yellow. Lower glume of sessile spikelet narrowly lanceolate, nerves on back echinulate. *Fls. & frts.* : August-November. Rare, growing along the rocky crevices. Taroba National Park, *Malhotra* 122823.

This species was recorded by Gamble (1934) from Madras State. The present record extends its distribution further north.

ACKNOWLEDGEMENTS

We are thankful to Dr. R. S. Rao, Regional Botanist, Botanical Survey of India, Poona for kindly going through the manuscript and giving constructive suggestions and to the Director, Botanical Survey of India, Calcutta, for providing the facilities.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE, POONA-1,
November 30, 1971.

S. K. MALHOTRA
SIRASALA MOORTHY

27. *UTRICULARIA STRICTICAULIS* STAPF FROM BHUBANESWAR—A NEW RECORD FOR ORISSA

Utricularia stricticaulis Stapf (=*U. reticulata* Sm. var. *uliginosa* C.B. Cl.) a species known from south Deccan Peninsula, Bengal and Ceylon, is recorded here for the first time from Orissa. The species is characterised by short scape with basifix scales, linear bracteoles ; suberect pedicels in fruiting, acute, yellow, decurrent calyx, enlarged in fruit, bluish corolla about equalling the calyx ; obovoid, slightly dorsiventrally compressed capsule ; elongate obovoid striated seeds with elongate epidermal cells. The species is closely related to *Utricularia uliginosa* Vahl, *U. graminifolia* Vahl and the African *U. spiralis* Sm. which, however, differ in the seeds or the corolla. Seeds in *U. uliginosa* and *U. spiralis* are globose with isodiametric epidermal cells. *U. graminifolia* differs in twining scapes, larger corolla and the lower corolla-lip and spur exceeding the purplish calyx.

Bhubaneswar, in rice fields, *fl.* & *fr.* 22-xii-1971. *Saxena* 277.

REGIONAL RESEARCH LABORATORY, H. O. SAXENA
BHUBANESWAR,
January 7, 1972.

28. SOME INTERESTING AND RARE PLANTS FROM MAHARASHTRA STATE

(*With four plates*)

During botanical explorations in the Phonda-Ambolighat area of Ratnagiri district (Maharashtra State) from the year 1965 onwards, some interesting and noteworthy plants have been collected and are being reported as additions to the Flora of Maharashtra.

The species reported here are not only new records for Maharashtra but also interesting from phytogeographic point of view as these were earlier recorded southwards from North Kanara and the present report shows their wider distribution.

While examining critically the collections from Ratnagiri district, another interesting plant *Polygonum strictum* All. collected from Mahableshwar (Satara district) was also worked out and has been reported in this paper. The collection includes two rare grasses namely, *Bhidea burnisiana* Bor and *Danthonidium gammiei* (Bhide) C. E. Hubbard, obtained in recent explorations in Ratnagiri.

In this paper, correct nomenclature, diagnostic characters of each species, collector's name, field no., habitat as well as critical notes are given.

All the specimens cited in this paper have been deposited in the herbarium of Western Circle, Botanical Survey of India, Poona (BSI).

BORAGINACEAE

Heliotropium cornutum Johnst. *in* Contr. Gray Herb. Henr. 92 : 90, 1930 ; Fischer in Fl. Mad. Pres. Part 11 : 1883, 1936 ; Arora & Banerjee *in* Bull. bot. Surv. India **8** : 341-342, 1966.

Prostrate to suberect herb. Flowers white in small helicoid cymes.

Rare, as a weed, in the rice fields in association with *Heliotropium scabrum* Retz. and *Coldenia procumbens* Linn.

Arora & Banerjee (loc. cit.) reported this plant as endemic to South Kanara (Mysore State). The present collection is an extension of distribution further north along the Western Ghats and is also a new record for Maharashtra.

Specimens examined. Ghotge, Kudal taluka, *Kulkarni* 107868.

SCROPHULARIACEAE

Bacopa floribunda (R. Br.) Wettst. *in* Engl. & Prantl Pflanzenfam. 4(3b) : 77, 1895. *Herpestis floribunda* R. Br. Prodr. 442, 1810 ; Hook. f. Fl. Brit. Ind. **4** : 273, 1884. *Moniera floribunda* Cooke, Fl. Bomb. Pres. **2** : 286, 1904.

A delicate erect herb, 8-10 cm tall. Flowers pedicellate. Capsules long, subglobose. Seeds oblong, truncate at both ends.

Rare, on wet sandy soil associated with *Cyanotis* sp.

Cooke (loc. cit.) states ' The occurrence of this plant in the Bombay Presidency is somewhat doubtful. Woodrow reports its occurrence from S. Kanara. Law has in his Herbarium Kew, specimens from Kanara and Mysore and of these the Kanara ones are most probably also from S. Kanara '. The present records show extension of distribution through Goa (Rolla Rao 1969, unpublished).

Specimens examined. Deobag, Malvan, *Kulkarni* 121336.

POLYGONACEAE

Polygonum strictum All., Auct. Syn. 42, 1773 et Misc. Taur. **5** : 94, 1774-76 ; Wt. Icon. t. 1800, 1852 ; Dandy in Taxon **19**(4) : 623, 1970. *P. minus* Huds. Fl. Angl. 148, 1762; Meissn. *in* DC. Prodr. **14** : 111, 1857 ; Hook f. Fl. Brit. Ind. **5** : 36, 1886 ; Gamble Fl. Mad. Pres. Part 7 : 1189, 1925.

Annual herb, rooting at nodes. Stipules sparsely strigose, ciliate. Flowers, minute, pink. Bracts stiff, ciliate on the margins. Perianth eglandular.

Rare, in water logged soil.

This species has been earlier reported from Nilgiris and Palni hills in south India. This report is an extension of distribution and a new record for the State.

Specimens examined. Near lake, Mahableshwar, *Ansari* 67688.

POACEAE

Coelachne simpliciuscula (Wt. & Arn.) Munro & Benth. *in* Journ. Linn. Soc. Bot. **19** : 93, 1881 ; Bor, Grass. Burma, Ceylon, India, Pak. 576, 1960. *Coelachne pulchella* R. Br. var. *simpliciuscula* Hook. f. Fl. Brit. Ind. 7 : 270, 1896 (non R. Br. 1810).

Suberect or trailing annual grass. Spikelets in speciform panicles, with short usually ascending branches.

Rare, near the streams or nallahs in association with *Centella asiatica* (L.) Urban.

This species has been reported from South Kanara downwards from an altitude of 600-1825 m. Of late, it has also been collected from Londa in Belgaum district (Mysore State) by the Botanical Survey of India. The present record is a northward extension of its range.

Specimens examined. Solia jungle, Chaukul (10 km from Ambolighat), *Kulkarni* 108631 ; Londa, *Ansari* 78597.

Dimeria hohenackeri Hochst. ex Miq. *in* Verh. Nederl. Inst. **3** : 35, 1851 ; Bor, Grass. Burma, Ceylon, India, Pak. 142, 1960. **(Plate I).**

Annual grass, 20-30 cm high, golden yellow. Spikelets parallel to rachis, delicate.

Rare, on rocky plains in association with *Dimeria stapfiana* C. E. Hubb. and *Cyperus* sp.

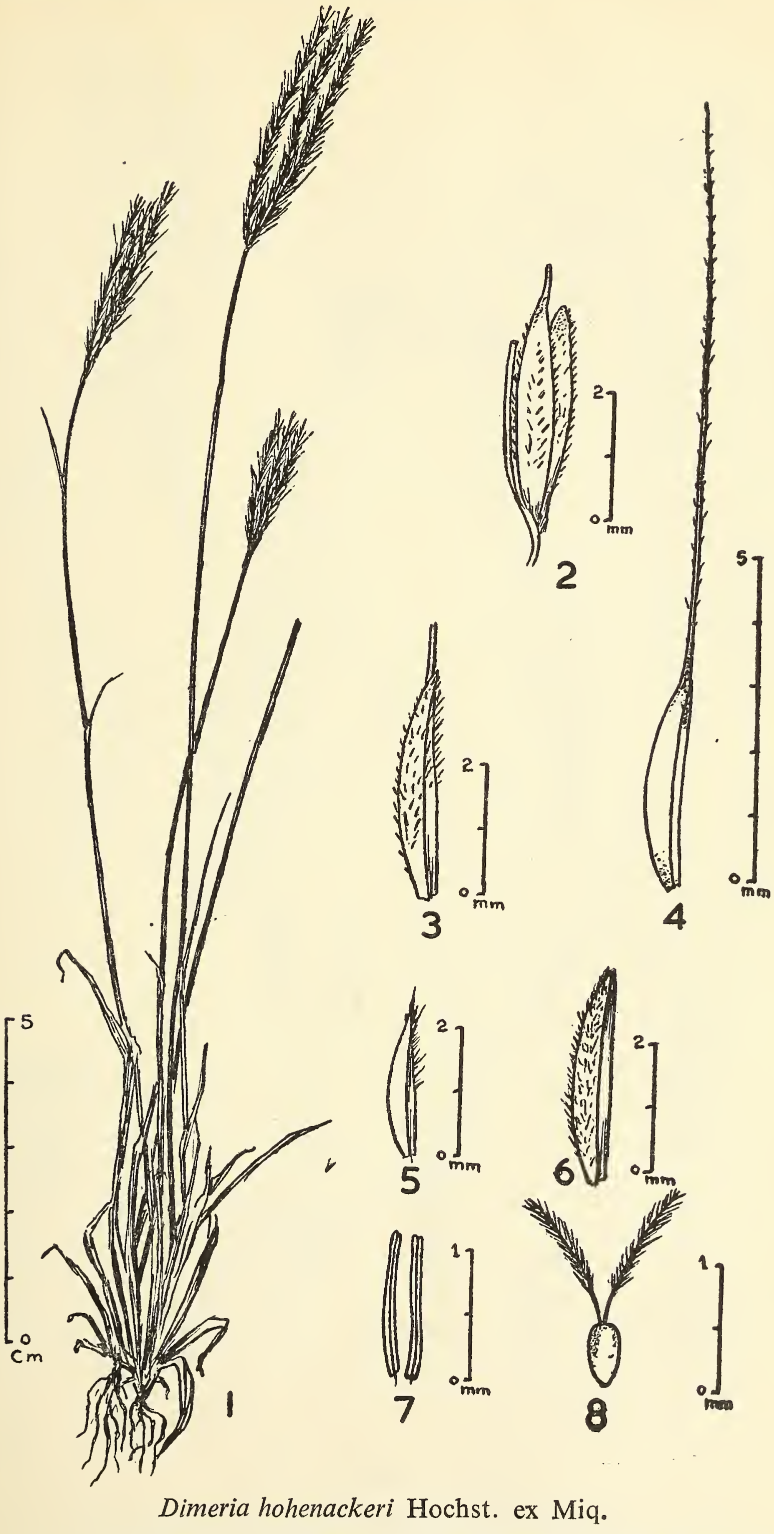
This species is distinguished from other closely allied species, namely *D. stapfiana* on the basis of parallel arrangement of spikelets on the rachis.

Bor (loc. cit.) mentions this species as endemic to Mangalore (Mysore State). There is every possibility of its occurrence between Mangalore and Ambolighat but it has escaped the attention of botanists so far. Besides being a distributional record, the present report is also a new record for Maharashtra.

Specimens examined. Mangaon, *Kulkarni* 106428.

Dimeria woodrowii Stapf in Hook. Icon. Pl. sub tab. 2312, 1894 ; Bor, Grass. Burma, Ceylon, India, Pak. 144, 1960. **(Plate II).**

Annual grass. Spikelets awned. Rachis of each raceme coiled into a hoop.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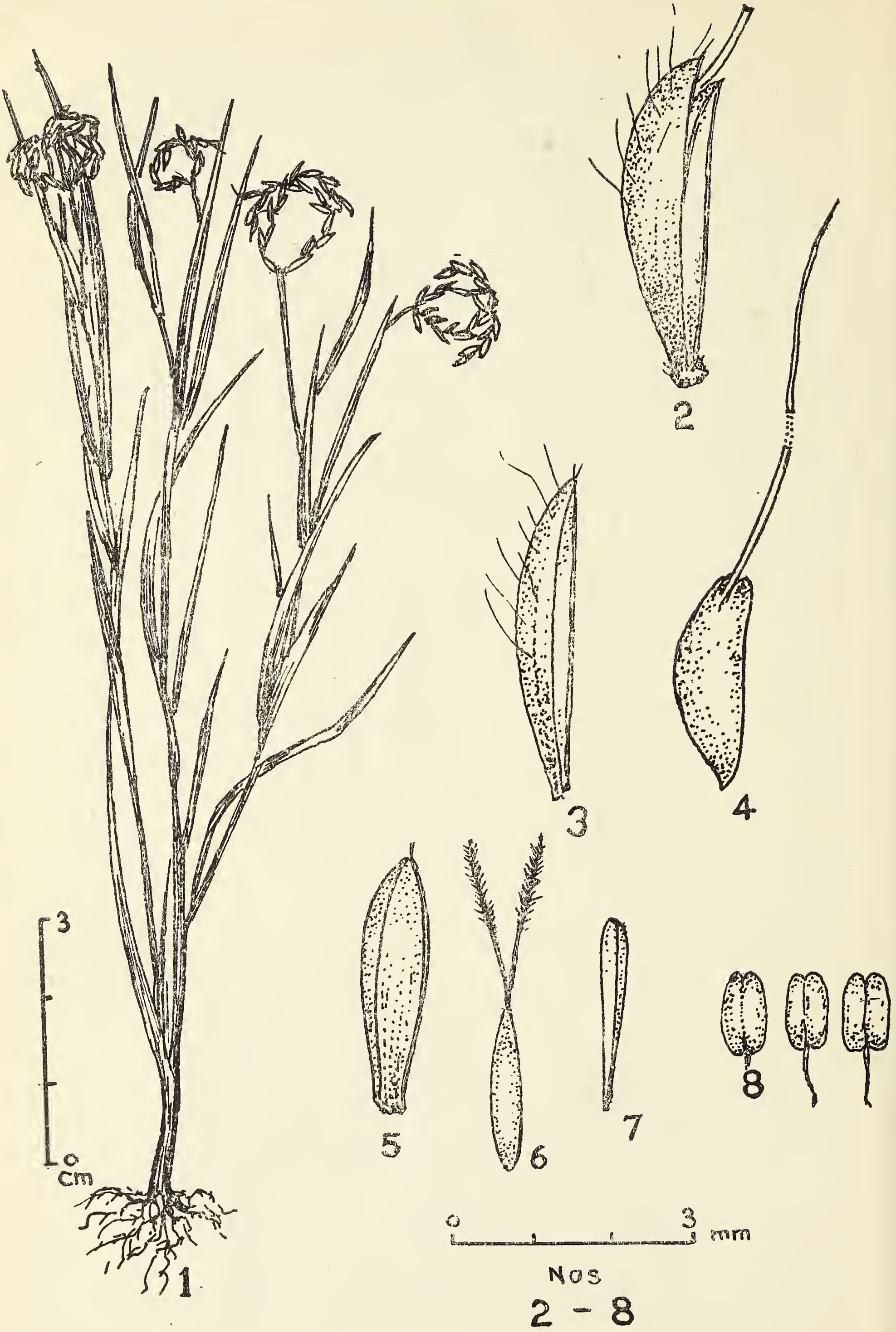
Dimeria hohenackeri Hochst. ex Miq.

1. Whole plant ; 2. Spikelet ; 3. Upper glume ; 4. Upper lemma ; 5. Lower lemma ; 6. Lower glume ; 7. Stamens ; 8. Ovary with style and stigma.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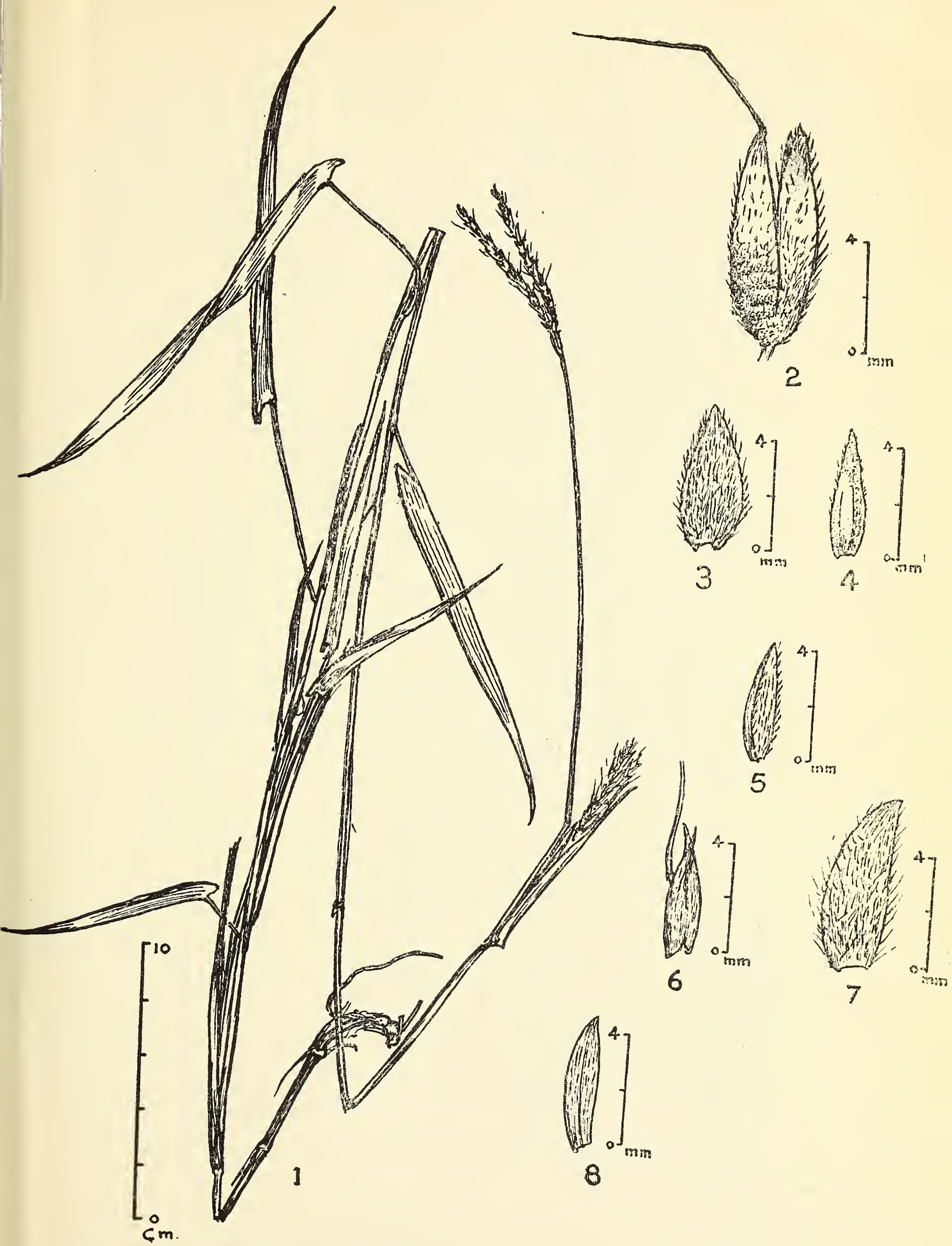
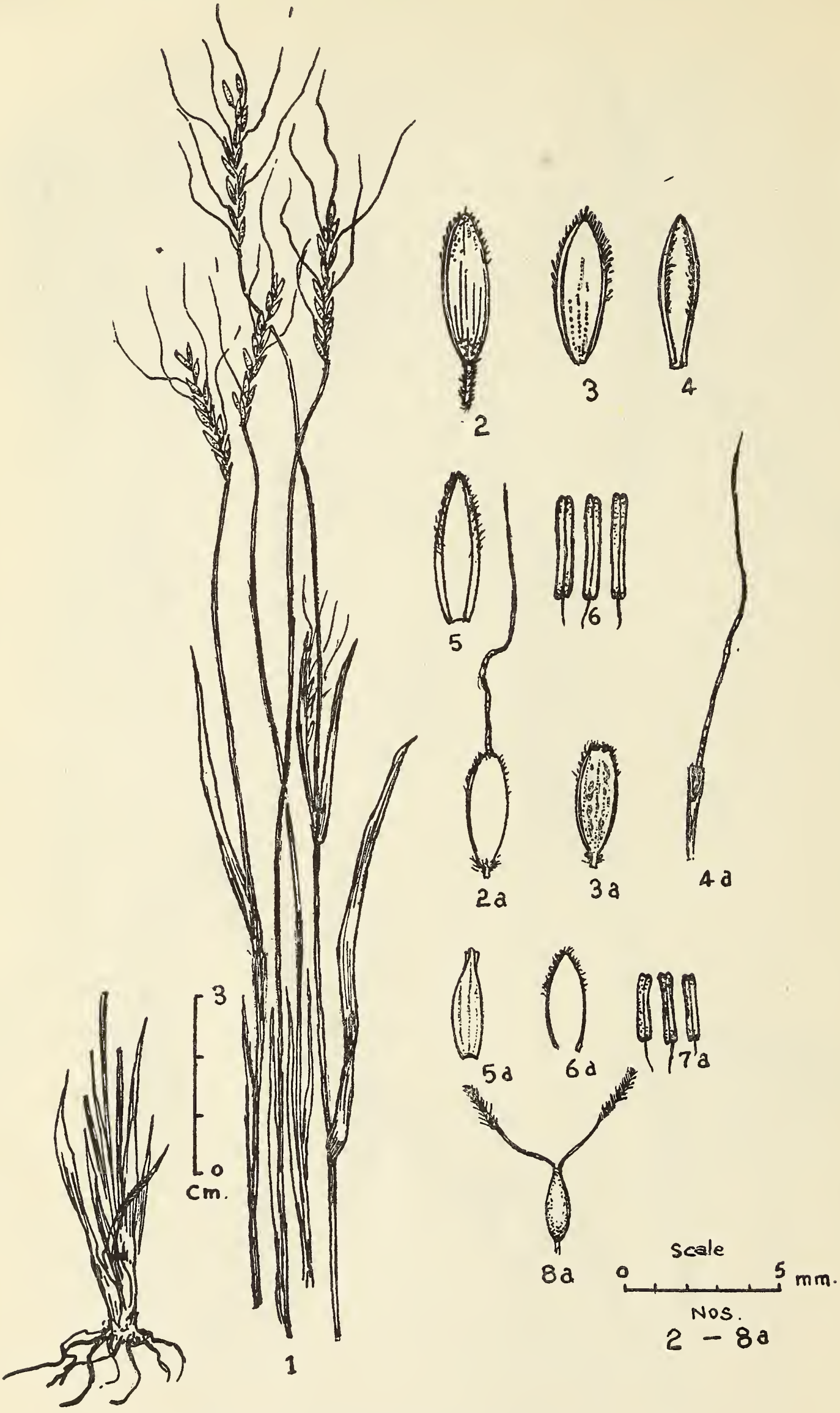
Dimeria woodrowii Stapf

1. Whole plant; 2. Spikelet; 3. Upper glume; 4. Upper lemma; 5. Lower glume; 6. Ovary with style and stigma; 7. Lower lemma; 8. Stamens.



Ischaemum dalzellii Stapf ex Bor

1. Whole plant ; 2. A pair of spikelets. *Sessile Spikelet* ; 3. Lower glume (dorsal view) ; 4. Upper involucral glume ; 5. Lower lemma (ventral view) ; 6. Upper lemma. *Pedicelled spikelet* : 7. Lower glume ; 8. Upper glume.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Schizachyrium paranjpeanum (Bhide) Raiz. et Jain

1. Whole plant; 2. Pedicelled spikelet; 3. Lower glume (ventral view); 4. Upper glume; 5. Lower lemma; 6. Stamens.

2*a*. Sessile spikelet; 3*a*. Lower glume; 4*a*. Upper lemma; 5*a*. Upper glume; 6*a*. Lower lemma; 7*a*. Stamens; 8*a*. Ovary with style and stigma.

Common, on rocky plateau in association with *Manisuris goaensis* Rolla et Hem. and *Ischaemum* spp.

Talbot No. 2557 (type sheet) cited by Bor (loc. cit.) from Bombay is actually not from Bombay, but from Goa (Marmagao, collected on October 15, 1891) as per locality given on the isotype available in herbarium of Western Circle, Botanical Survey of India, Poona. The new report is the second collection after a lapse of 79 years from an adjoining area of the type locality.

Specimens examined. Adari-Nandruk, Malwan, *Kulkarni* 121287.

Ischaemum dalzellii Stapf ex Bor *in* Kew Bull. 1951 : 448, 1952 ; Bor, Grass. Burma, Ceylon, India, Pak. 178, 1960. (Plate III).

A robust grass up to 1 m tall. Lower leaves petiolate, hastate at base of lamina. Joints of the racemes linear-clavate; lower spikelets often hairy.

Rare, on rocky plateau along with *Ischaemum pilosum* (Klein ex Willd.) Wt., *I. timorense* Kunth. and *Schizachyrium paranjpeanum* (Bhide) Raiz. & Jain.

This species has so far been collected from North Kanara (type locality). The present report indicates its extension further north into Ratnagiri district.

Specimens examined. Ambolighat, *Kulkarni* 106369A.

Schizachyrium paranjpeanum (Bhide) Raiz. & Jain *in* Proc. Ind. Sci. Congr. Abst. Part 3 : 130, 1953 ; Bor, Grass. Burma, Ceylon, India, Pak. 216, 1960. *Andropogon paranjpeanum* Bhide in J. Proc. Asiat. Soc. Beng. (n.s.) 7 : 514, 1911. (Plate IV).

Annual tufted, delicate grass. Spikelets in long exerted racemes from the subtending sheaths.

Rare, on open rocky plateau of Ambolighat Reserve Forest in association with *Ischaemum pilosum* (Klein ex Willd.) Wt. and *Ischaemum dalzellii* Stapf ex Bor.

Bor (loc. cit.) states that this species is probably endemic to Castlerock (North Kanara district, Mysore State). The present report indicates its extension of distribution and is a new record for Maharashtra. Besides, this species is extremely rare from the fact that it is collected after a lapse of 56 years. The last collection (type material) was made in 1909, by R. K. Bhide from Castlerock.

Specimens examined. Ambolighat, *Kulkarni* 106365.

ACKNOWLEDGEMENTS

We are thankful to Dr. R. S. Rao, Regional Botanist, Botanical Survey of India, Poona, for kindly going through the manuscript and giving constructive suggestions and to the Director, Botanical Survey of India, Calcutta for providing the necessary facilities.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE,
7-KOREGAON ROAD, POONA-1,
January 1, 1972.

B. G. KULKARNI
B. M. WADHWA

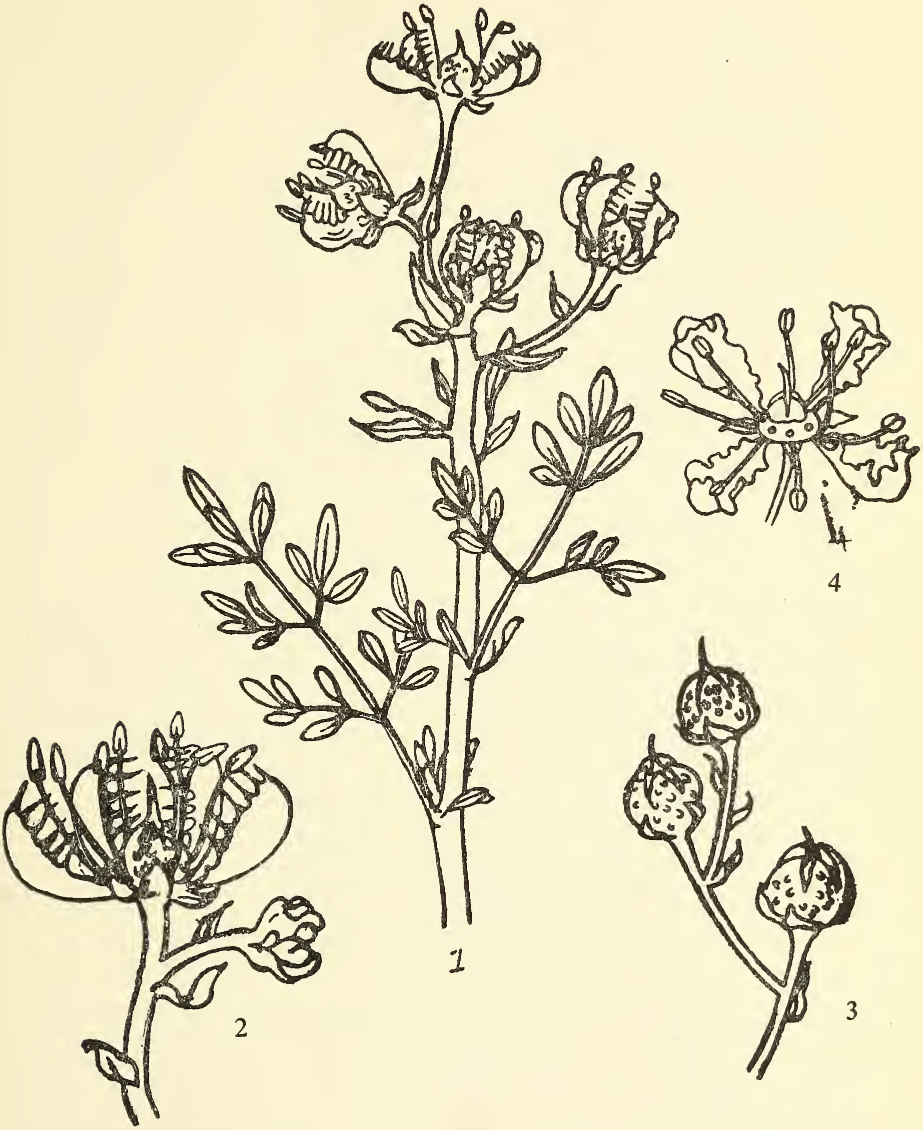
29. ON THE OCCURRENCE OF *RUTA CHALEPENSIS* LINN. IN INDIA

(*With a plate*)

While reviewing the literature on the species of *Ruta* Linn. for the WEALTH OF INDIA, a Dictionary of Indian Raw Materials, published by the Council of Scientific & Industrial Research, some doubts were cast on the identity and nomenclature of the plant reported from India. Hooker in FLORA OF BRITISH INDIA, recorded under the name *R. graveolens* Linn. var. *angustifolia* Hook. f. (syn. *R. angustifolia* Pers. and *R chalepensis* Wall., Cat. 7113), a plant said to be introduced and cultivated in India and comprising one or more forms. He seems to have considered the Indian plant as a variety, on the basis of the floral petals having ciliated margins, a feature by which *R. angustifolia* Pers. and *R. chalepensis* Linn. have been distinguished from *R. graveolens* : in *R. graveolens* the petals have wavy or slightly dentate margins. All the subsequent Indian works mentioned the plant as *R. graveolens* var. *angustifolia*, or as *R. graveolens*, and attributed many of the economic properties known mostly for *R. graveolens* to the Indian plant. Some reproduced along with their account, also a figure of *R. graveolens* redrawn evidently from European sources. In the figures reproduced, the petals of the flower are clearly shown to have wavy or slightly toothed margins so characteristic of *R. graveolens* and not ciliated as recorded for the Indian plant in FLORA OF BRITISH INDIA (Vol. I, pt. 3, p. 485).

According to recent European works, such as FLORA EUROPEAN, vol. 2, p. 227 ; 1968, the three species mentioned above, namely *R. graveolens*, *R. chalpensis* and *R. angustifolia* are considered distinct from one another, differing in their floral characters. *R. graveolens* is distinguished from the latter two, in having the petals with more or less wavy or denticulate

Ramanathan & Ramachandran : *Ruta chalepensis*



1. *Ruta chalepensis* Linn. flowering branch (×2).
2. Flower showing the ciliated margins of petals (×2).
4. Fruiting branch showing the sharply pointed lobes (×2).
3. *Ruta graveolens* Linn. flower showing the denticulate margins of petals (Redrawn from Bentley and Trimen).

margins (Fig. 4), while *R. chalepensis* and *R. angustifolia* are similar to each other, in having petals with ciliated margins, i.e. with long, conspicuous, upstanding, tooth-like hairs (Fig. 1 and 2). Further in *R. graveolens* the capsules are reported to have somewhat rounded lobes, while in the other two, the capsules have sharply pointed lobes (Fig. 3). Between *R. angustifolia* and *R. chalpensis*, the former is said to differ from the latter, mainly in the marginal hairs being as long as the width of the petals and the bracts not broader than the subtending branch. However, according to some authorities, (Chittenden 1951, Uphof 1968) *R. angustifolia* is considered as a synonym of *R. chalepensis* or only as a variety, *R. chalepensis* Linn. var. *angustifolia* (Pers.) Wilke et Lange (Mansfeld 1959).

While dealing with *R. graveolens* in Malaya, Burkill (1935) stated, that *R. graveolens* seems to have spread into India overland at no very distant date and ' the Rue has been adopted so thoroughly in India that, in some parts such as Bombay, it is planted in almost every garden.' In order to confirm whether the plants are still grown in Bombay, fresh specimens were obtained from Poona and Bombay, through the courtesy of Prof. V. S. Rao, Ramnarain Ruia College, Matunga, Bombay. An examination of the floral parts showed that the plant commonly grown in Bombay and Poona agreed closely with the description of *R. chalepensis* Linn. rather than with *R. graveolens* or even var. *angustifolia*. Fresh plants obtained from other centres also, namely Bangalore, Coimbatore and Banaras, all appeared to be of *R. chalepensis* and not of *R. graveolens*. All of them had hairs on the margin of their petals, but not as long as reported for *R. angustifolia* ; none of them had denticulate or wavy margins, characteristic of *R. graveolens*. As far as present enquiries indicate, all the plants examined from various centres in India appear to be of *R. chalepensis* Linn. Although it is not improbable that *R. graveolens* may be grown in some places, its record in India could not be confirmed at present.

Besides the differences in the floral characters mentioned already between *R. graveolens* on one hand and *R. chalepensis* and *R. angustifolia* on the other, there is also a difference in their chromosome number (Darlington & Wylie 1965). *R. chalepensis* is reported to have $X=36$ chromosomes, while *R. graveolens* has $X=72$ or 81. The characteristics of the essential oil obtained from the two species are also known to differ in detail (Guenther 1952). Oil distilled from *R. graveolens* is said to contain chiefly methyl nonyl ketone, while oil from *R. chalepensis* (syn. *R. bracteosa* DC.) contains chiefly methyl heptyl ketone.

The plants received recently from various places are all reported to be cultivated and used for the same purpose for which *R. graveolens* is reputed, although as shown above they truly belong to *R. chalepensis*. While it is not improbable the plants may possess all those attributes, no actual investigation has been made either of the chemical constituents or the medicinal properties of the Indian material. This note has been written mainly to bring to the notice of Indian scientists the need for a detailed investigation of the Indian material.

ACKNOWLEDGEMENTS

Our thanks are due to Prof. V. S. Rao (Bombay), Dr. M. H. Marigouda (Bangalore), Dr. Daniel Sundararaj (Coimbatore) and Dr. R. S. Singh (Banaras), for their ready response in sending fresh specimens from their localities and to late Sri S. Jayaram Sharma for preparing the illustrations. Our thanks are also due to Sri A. Krishnamurthi, for his interest.

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NEW DELHI-12,
December 12, 1970.

K. R. RAMANATHAN
KAMALA RAMACHANDRAN

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Notes and News

Symposium on Ecological Studies in the Gir Wildlife Sanctuary

Under the auspices of the Bombay Natural History Society, World Wildlife Fund—India, and the Indian Board for Wildlife, a symposium on ecological studies in the Gir Wildlife Sanctuary was held at the India International Centre, New Delhi, on 17th November 1972. Paul Joslin of the University of Edinburgh, K. T. B. Hodd of Aberdeen University, and S. H. Berwick of Yale University, all of whom had studied some aspect or other of the Gir Forest ecosystem were invited to participate in the symposium.

Zafar Futehally, introducing the speakers to the audience referred to the special responsibility of conservationists towards fostering good international relationships, 'for the simple reason that nature respects no man made boundaries and we cannot do better than follow her wise example'.

Paul Joslin summarised some of the important reasons for the present decline in the lion population in Gir forest. The lion's habitat in the Gir forest has been considerably reduced in the last few decades by human encroachment, and this has reflected on the number of lions since they are territorial animals.

The population of domestic livestock living permanently inside the Sanctuary as well as the migrant cattle which come during the rains has had a strong impact on the feeding habits of the lion. Domestic buffaloes and cattle now far outnumber the natural prey species of the lion. An analysis of 500 lion droppings showed remains of 75% domestic animals and 25% wild animals. While studying the lion kills in the Sanctuary Joslin found that 24% of the kills were not consumed by lions. This was largely due to human interference, as fifty per cent of the kills were appropriated by local harijans for hide and meat and this operation disturbed the lions. Incidentally I was concerned with the study of the ecology and behaviour of vultures in the Gir and I found that the remains of most of the lion kills visited by harijans were consumed by vultures. The reasons were : (1) by dragging out the kills from dense cover to the open the harijans helped vultures to spot the carcasses much more easily ; (2) by chasing away the lions they enabled vultures to come down and feed fearlessly, and (3) by skinning the kills they made it possible for vultures to clean up the carcasses in minutes.

K. T. B. Hodd's research was aimed at finding out how the lion habitat was changing because of grazing by domestic livestock, and to investigate ways to prevent the habitat from further deterioration. He studied some aspects of the domestic animals' impact on the lion's habitat, namely the effects of domestic animals on the grass and forbes, the effects of domestic animals and their graziers on the capacity of the forest trees to regenerate naturally and the effects of domestic animals on the structure of the soil.

His significant findings were :

1. There are about four times as many domestic animals as can be safely allowed to graze in the Gir. This has resulted in overgrazing and trampling of the soil, which in turn has inhibited the growth of grass.

2. Trampling has begun to destroy the porosity of the Gir soil, which is essential for productivity. Also exposure of the soil due to overgrazing has resulted in heavy soil erosion which is detrimental to the flora. By reducing the number of cattle to the optimum it is possible to recover the porosity and fertility of the soil. One of Hodd's recommendations was a rotational grazing system for the domestic livestock, involving splitting of the grazing lands around each ness into three equal parts and allowing the livestock to graze in one part for only four months a year.

S. H. Berwick studied the habitat relationships, numbers and distribution of wild ruminants of the Gir forest. He estimated about 6,800 wild ungulates in the Gir as against the 30,000 or more of the domestic buffaloes and Zebu cattle which graze within the sanctuary. The wild ungulates are the chital, sambar, nilgai, fourhorned antelope, chinkara and wild boar. Food preferences of domestic and wild ruminants for various plant species were studied by observing free-ranging animals. Additional data on this was collected from feeding choice experiments using captive animals, from feeding choices of captive leashed animals in the field, from analysis of rumen contents of animals recovered in the field, and from identification of microscopic plant fragments in fecal pellets of free-ranging wild ruminants. Other studies included energy flow and balance of nature in the Gir ecological system. He found that up to 90% of the annual production of grasses is removed primarily by domestic livestock and this constitutes a serious imbalance between vegetative production and grazing. Also much of the energy and nutrients cycled through domestic stock is lost to the Gir ecosystem because of the removal of dung and butter for use outside the Sanctuary.

Since the researchers had not yet fully analysed their data they did not submit written papers at the symposium but papers will be published when ready.

After the talks by the three researchers, Shri Dharmakumarsinhji led a floor discussion in which many members of the audience participated.

ROBERT B. GRUBH

Gleanings

India a Hundred Years ago

'The lion, which was long supposed to be unknown in India, is now ascertained to exist in considerable numbers in the districts of Saharanpur and Ludhiana. Lions have likewise been killed on this side of the Ganges, in the northern parts of Rohilkhand, in the neighbourhood of Moradabad and Rampur, as large, it is said, as the average of those in the neighbourhood of the Cape of Good Hope. Both lions, where they are found, and tigers, are very troublesome to the peoples of the villages near the forest, who, having no elephants, have no very effectual means of attacking them with safety. The peasantry here, however, are not a people to allow themselves to be devoured without resistance, like the Bengalees, and it often happens that, when a tiger has established himself near a village, the whole population turns out, with their matchlocks, swords, and shields, to attack him. Fighting on foot and compelled to drive him from his covert, by entering and beating the jungle, one or two generally lose their lives, but the tiger seldom escapes; and Mr Boulderson[1] has seen some skins of animals of this description, which bore the strongest marks of having been fought with, if the expression may be used, hand to hand; and were in fact slashed over with the cuts of the "talwar" or short scimitar. A reward of four rupees for every tiger's head brought in, is given by Government; and if the villagers of any district report that a tiger, or lion, is in the neighbourhood, there are seldom wanting sportsmen among the civil or military officers, who hear the news with pleasure, and make haste to rid them of the nuisance. A good shot, on an elephant, seldom fails, with perfect safety to himself, to destroy as many of these terrible animals as he falls in with.' (INDIA A HUNDRED YEARS AGO, by Bishop Heber, D.D. First published by Longmans in 1927).

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[1] Collectod in 1824-5 of what are now Shahjehanpur and Pilibhit districts.—EDS.

Announcement

Sálim Ali/Loke Ornithological Research Fund

The Fund has been established by the *Bombay Natural History Society* with the object of promoting scientific ornithology and bird preservation in India.

Monetary assistance will be given to biologists, whether graduates or not, preferably between the ages of 20 and 30 years and preferably resident within the Indian sub-Region, desirous of undertaking research projects approved by the Executive Committee of the Society.

Assistance may take the form of small grants, either a lump *ad hoc* sum or tenable over a specified period. Details of the problem intended to be followed should be submitted to the Honorary Secretary, along with particulars of the candidates qualifications to undertake the study and details of the financial assistance required.

Research Fellowships may be granted for more serious problems extending over a long period. The rules relating to the Fellowships may be obtained from the Honorary Secretary.

Charles McCann Vertebrate Zoology Field-Work Fund

This Fund originated in 1972 in a grant Rs. 14,398.55 made by Mr. Humayun Abdulali, being the unspent balance of a sum of Rs. 20,000 paid by him towards the expenses of three natural history expeditions to the Andaman and Nicobar Islands, reports of which have appeared in the pages of the *Journal*. In 1972 at the instance of Mr. Humayun Abdulali the Fund was given its present name in honour of Mr. Charles McCann (at present in New Zealand), Assistant Curator of the Society from 1922 to 1947, who during his stay in India made several notable contributions to our knowledge of the botany and zoology of the Indian Region. Recently the Society has received a generous contribution of Rs. 2,500 towards the Fund from Shri Fatehsingh Rao Gaikwad of Baroda. Further contributions will be welcome. Persons wishing to avail themselves of help from the Fund should apply to the Honorary Secretary, giving particulars of the proposed field-work and the extent of the help required.

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Kaziranga Wild Life Sanctuary, Assam[1]

A BRIEF DESCRIPTION AND REPORT ON THE CENSUS OF LARGE ANIMALS (MARCH 1972)

BY

P. LAHAN[2] AND R. N. SONOWAL[3]

INTRODUCTION

In Kaziranga Wild Life Sanctuary the object and methods of management are to a large extent Rhino oriented in so far as the sanctuary holds the largest number of surviving great Indian one-horned rhinoceros. For sound scientific management of wild life basic data are required on the Ecology of the habitat, species living in the habitat, population dynamics of each species, inter and intra specific reaction of the various species of wild life and their influence on the habitat, carrying capacity of the area, and food habits. To collect such basic data considerable amount of field research is necessary.

As a part of this programme a census of the rhinoceros in Kaziranga was carried out in 1957, 1963 and 1966. However the first scientific and systematic census of larger mammals of Kaziranga including the rhinoceros was conducted in 1966 only by the Forest Department with the help of Mr. H. K. Nath and Dr. J. J. Spillett. Due to various reasons census of the wild animals in the Kaziranga Sanctuary could not be carried out during the subsequent years after 1966. A census of the larger mammals of the Kaziranga Wild Life Sanctuary was carried out during the year on the 24th and 25th of March 1972, after a lapse of six years.

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A brief description of the Kaziranga Wild Life Sanctuary and the details of the census operation form the text of this report.

Kaziranga Wild Life Sanctuary

Situation, Topography and Area:

The Kaziranga Wild Life Sanctuary is situated partly in the civil district of Sibsagar and partly under Nowgong district in the state of Assam, India (90°5′ and 93°40′E) (26°30′ and 26°45′N) in the flood plain of the Brahmaputra River at the foot of the Mikir Hills south of National Highway No. 37. The area has been formed by the deep alluvial deposits of the Brahmaputra River and is flat with a east to west slope.

The general climate of the area is tropical characterised by heavy rainfall evenly distributed throughout the year. Comparatively dry months are from November to February and hottest months of the year are June to September.

The mighty Brahmaputra River flows along the northern boundary of the sanctuary, the River Mora Diflu along the southern boundary and the Rivers Diflu and Bhengra flow through the sanctuary from the east to west. Other important small streams originating in the Mikir Hills draining into the sanctuary from south to north are Borjuri, Diring, Kohora, Dehing, Bhalukjuri, Deopani, etc. There are numerous seasonal nullahs inside the sanctuary. All rivers and nullahs discharge into the Brahmaputra River. In addition to the rivers and streams the whole sanctuary is dotted with numerous beels (lakes).

The total area of the Kaziranga Sanctuary is 42,496 hectares or 429.96 sq. km. However there is constant change in the exact area of the sanctuary due to erosion and formation of new land on the northern boundary of the sanctuary by the Brahmaputra River. The present area of the sanctuary is 37,822.43 hectares only.

Legal Status:

Originally Kazinranga was formed into a reserve forest in the year 1908 with the primary objective of preserving the rhinoceros and other wild animals. Hunting and shooting in this reserve forest has been prohibited since then. The area was declared as a game sanctuary in the year 1916 for the first time and later rechristened as a wild life sanctuary.

With the passing of the Assam National Park Act of 1968 and obtaining of the assent of the President of India on 29th April 1969, it is now proposed to convert the sanctuary into National Park under this act. Preliminary notifications in this regard has already been published vide notification No. FOR|WL|722|45, dt. 23-9-1969 and other necessary formalities have been completed.

It is expected that the final notification declaring the sanctuary as a National Park will be published shortly.

No rights and privileges are exercised in the sanctuary for any forest produce or right of way etc. There is no exploitation of any forest produce in the sanctuary.

Grazing inside the sanctuary is allowed to a limited extent near Arimora, Bhawani and Kaziranga to some professional graziers. But grazing will be completely eliminated as soon as the sanctuary is declared as a National Park.

Biotic and Edaphic factors:

Fire: Every year the grasses are burnt by the wild life staff of the sanctuary from December to February. Accidental fire is also not uncommon. However burning is never complete all over the area. Burning is done with a view to encourage new growth of grasses as well as to facilitate patrolling. It has been observed that new and tender shoots of grasses come up immediately after the burning as soon as the area gets a winter shower. Animals concentrate in such burnt patches for the ash. The rhinoceros and the elephants relish the partially burnt stems of tall grasses like *Arundo donax, Phragmites karka, Erianthus* spp. etc.

The frequency of sighting of animals in the unburnt areas is minimal. In areas not burnt every year the grasses grow into a tall thick mass that animals passing through have to tunnel through it. No other grasses grow under such thick masses of tall grass and hence such areas are not used by animals for grazing. The tall grasses grow to such heights that no other animal except the elephant can reach the shoots.

The practice of burning the grasslands have been continued for the last so many years without affecting the nature of the vegetational growth and it appears that fire is one of the essential factors in maintaining the grasslands in its present state. Fire hardy tree species try to colonise the grasslands every year by profuse natural regeneration along the existing tree patches. But this process is arrested by the annual fires of the grasslands.

No burning takes place in the evergreen tree forests and such areas along with the unburnt patches of grasslands provide shelter for the animals.

Flood: Like fire, flood is also an annual feature of the sanctuary. During rainy season the numerous rivers and streams passing through the sanctuary flood the entire sanctuary. During high floods the water of the Brahmaputra River also enters the sanctuary and the entire area is submerged leaving only a few high ground above water. The flood water maintains its highest level from 5 to 10 days. During this period the animals concentrate and take shelter on the roads and high grounds in the sanctuary.

A large number of animals migrate from the sanctuary to the nearby Mikir Hills after crossing the National highway. The deer population suffers extensively during high floods. The rhinos and buffaloes are not much affected.

High floods submerging the whole sanctuary and the highlands inside it and depriving the animals of fodder and shelter is definitely detrimental to the wild animals which are forced to seek shelter in the hills outside the sanctuary exposing themselves to the danger of predation by man. During such high floods herds of deer are found resting at night on the highway. Sighting of elephants, buffaloes, rhinos and pigs crossing over to the hills are also not rare.

The receding flood waters wash away the water hyacinth from the beels, streams and nullahs which grows into thick inpenetrable mass depriving ducks etc. of foraging grounds. The flood waters replenish the beels and nullahs. The flood waters recede slowly and it takes considerable time for the low lying areas to dry maintaining the swampy nature which helps to arrest species succession. The flood waters add to the fertility of the soil with fresh alluvial deposits which in turn support a rich growth of fresh green grasses throughout the year.

With the flooding of the beels the numerous fishes living in them come out to lay eggs in the current of the flood water. The fishes from these beels go out to the Brahmaputra River along with the receding flood water. Thus Kaziranga serves as a breeding ground for fishes and for replenishing the fish stock of the Brahmaputra River.

The flooding of the sanctuary has been a recurring feature for the last so many years that it is difficult to think of Kaziranga without flood. Fire and flood are considered to be two essential agents for maintaining the present vegetational stage. Floods of lower intensity are beneficial to the wild life and the sanctuary in general. But high floods submerging the entire sanctuary is definitely injurious as animals are lost during such floods. However high floods do not occur annually.

Erosion: Erosion is one of the major factors playing a vital role in the future of the sanctuary. Every year large chunks of land from the northern boundary of the sanctuary are washed away by the Brahmaputra River. New river islands are also formed near the sanctuary.

But due to legal complications such islands cannot be added into the sanctuary prior to completion of many formalities. Other new areas formed by silt deposition adjoining the sanctuary takes time to stabilise and support vegetational growth. The seriousness of the damaged done by erosion can be gauged from the fact that the present area of the sanctuary is 37,822.43 hectares against the original area of 42,496 hectares.

The areas of severe erosion go on changing according to the change in course of the Brahmaputra River. At present the worst affected area is in the western part of the sanctuary in Baguri block near Kawaimari.

Water Hyacinth: Water hyacinth has invaded almost all the rivers and beels of the sanctuary. The rapid growth and excessive spreading capacity of this weed has covered up many beels of the sanctuary depriving the migratory and resident water-birds of the sanctuary of their feeding grounds. The dry mass of water hyacinth lying on the banks of the beels after the drying up of the water is so thick during winter that it does not allow any grass to grow under it. However during high flood the bulk of the water hyacinth is washed out to the Brahmaputra River by the receding flood water.

Mikenia: Recently this climber has been observed to be spreading in many areas of the sanctuary. Though it has not created any problem until now it is a weed to be observed and controlled.

Disease: The wild animals of the sanctuary have not been affected by any serious epidemic disease during recent years. In 1944 and 1947 heavy casualties were reported amongst the rhino population due to Anthrax and another unidentified disease. As the sanctuary is within easy reach of the village cattle of the surrounding population the danger of epidemic spreading to the wild animals is always present. As such preventive measures against epidemic diseases are taken by innoculating the cattle population of the surrounding villages.

Poaching: Poaching has been almost eliminated from the sanctuary. The measures taken against poaching have become so strict and severe that no one thinks of taking the risk for shooting deer and such other animals. Poaching is confined to rhinoceros only. This problem will have to be faced for an indefinite period due to the high value attached to the rhinoceros' horn. In Government auction market the horn fetches a price of Rs. 10,000 per kilogram. However the poaching of rhinoceros has also been brought almost under control. The incidence of rhino poaching can be judged from the following figures:—

Year	No. of rhinos killed by poachers
1965	18
1966	5
1967	12
1968	10
1969	8
1970	2
1971	8

Some animals get killed during high flood when they migrate from the sanctuary and take shelter in the surrounding villages. But such incidents are inevitable. Occasional cases of illegal fishing inside the beels of the sanctuary in the vicinity of the villages are detected.

Other human interference:

The sanctuary is free from all other human interference as there is no exploitation. No one is allowed to enter the sanctuary except visitors accompanied by wild life staff. The only human interference is by way of patrolling and cutting of roads and paths by labourers under supervision of the wild life staff during winter.

Regular traffic of visitors on elephant back to the Mihimukh centre near the Tourist Lodge has so conditioned animals in the area that one can approach as near as 2 metres of a rhino, drive close to swamp deer and hog deer without disturbing them in any way and approach to within 3 to 4 metres of a herd of buffaloes. The rest of the sanctuary is an undisturbed wilderness.

The Habitat:

The entire area of the sanctuary is covered by extensive grasslands interspersed with evergreen tree forests and numerous beels. The number of such beels are more towards the western part of the sanctuary (i.e. Baguri block). The following table gives the areas under grassland, tree forests and beels (water) in different blocks.

Name of block	Forest areas in acres	Grassy areas in acres	Water areas in acres	Total area of the block in acres
Baguri	3,969.98	11,429.24	1,601.02	17,000.24
Haldhibari	1,111.80	8,146.66	551.26	9,809.72
Kaziranga	2,047.02	8,652.42	346.86	11,046.30
Panbari	2,071.00	8,155.38	593.16	10,819.54
Tamulipathar	3,211.14	6,271.86	436.00	9,919.00
Boralimora	3,464.02	4,549.66	444.72	8,458.40
Charighoria	5,909.98	6,110.54	316.34	12,336.86
Bhawani	4,379.62	8,921.18	929.04	14.229.84
Total:	26,164.56	62,236.94	5,218.40	93.619.90

27.95 per cent of the total area of the sanctuary is covered by tree forests 66.47 per cent by grasslands and 5.58 per cent by the beels. The percentage of tree forests is more towards the eastern part of the sanctuary than on the western part. Champion and Seth (1968)[1] have described the forest type as eastern wet alluvial grasslands (4D/252) which is an early arrested stage of a primary sere.

Tree forests:

The tree forests occupy the comparatively higher grounds along the bank of the streams and nullahs. The newly colonised areas along the bank of the Brahmaputra River consist mostly of scattered and sparse growth of semul and koroi. Evergreen trees predominate in the stable high grounds with scattered cane breaks. The undergrowth is very dense and the forests are almost impenetrable. Grasses are completely absent from the ground. On the other hand the undergrowth in the open forests of semul and koroi consists mainly of grasses.

Profuse regeneration of fire hardy species occurs in the periphery of the tree forests trying to colonise the grasslands. But the annual fire and flood prevents such colonisation by tree species and maintains the status of the habitat.

The main species found are *Salmalia malabarica, Albizzia procera, A. lebbek, A. stipulata, A. odoratissima, A. lucida, Careya arborea, Premna latifolia, P. bengalensis, Lagerstroemia parviflora, L. flosreginae, Trewia nudiflora, Tetramalis nudiflora, Stereospermum chelonoides, Alstonia scholaris, Spondias mangifera, Vitex peduncularis, V.*

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[1] Champion, H. G. & Seth, S. K. (1968): A revised survey of the Forest types of India. Manager of Publication. Delhi. 404 p.

trifolia, Dysoxylum procerum, Eugenia jambolana, E. operculatum, Ehretia acuminata, Chukrasia tabularis, Ficus cuneata, F. glomerata, F. religiosa, F. bengalensis, Bischofia javanica, Dillenia indica, Pterospermum acerifolium, Cedrella toona, Anthocephalus kadamba, Bridelia retusa, Kydia calycina, Sterculia villosa, Crataeva religiosa, Terminalia belerica, Listea polyantha, Sterculia alata, Artocarpus chaplasha, Mallotus philippensis, Oroxylum indicum, Salix tetrasperma, Talauma hodgsoni, Wrightia tomentosa, Holarrhena antidysenterica, Barringtonia acutangula, Aesculus punduana, Schima wallichii, Emblica officinalis, Zizyphus jujuba, Gmelina arborea, Bauhinia spp., *Cassia fistula, Randia dumetorum, Erythrina indica, Zanthoxylum budrunga*, etc.

The main species forming the undergrowth are *Polyalthia jenkinsii, Laportea crenulata, Phlogacanthus curriflorus, Melastoma* spp., *Alpinia allughas, Clinogyne dichotoma, Calamus* spp., *Rauwolfia serpentina, Solanum ferox, Solanum indicum, Xanthium strumarium, Ageratum conyzoides, Eupatorium odoratum, Mimosa pudica, Tamarix dioica, Amaranthus spinosus, Flemingia chappar, Chenopodium album, Clerodendron infortunatum, Colocasia esculenta, Aeschynomene indica, Cassia tora, Polygonum* spp. etc.

The main species of climbers are *Vitis latifolia, Paederia foetida, Ichnocarpus frutescens, Cardiospermum halicacabum, Mikenia* spp., *Trichosanthes dioica, Smilax vaginata, Mucuna pruriens* etc.

Grasslands: Almost two-thirds of the sanctuary is covered by grasslands consisting of both grasses and reeds. The reeds grow up to a height of fifteen to twenty feet during the rainy season. The main species of grasses and reeds are *Saccharum* spp., *Imperata cylindrica, Erianthus* spp., *Arundo donax, Phragmites karka.* Although these grasses grow side by side the various species have site preferences depending upon the moisture conditions of the soil.

The newly formed riverain areas along the Brahmaputra River are mostly covered by *Saccharum spontaneum, Imperata cylindrica, Erianthus filifolius* etc.

Erianthus ravaneae (Ekra) is the most common and widely distributed species in the sanctuary. It prefers the areas which get flooded during the rainy season and remain dry during the winter season. Mixed with Ekra, Borota kher (*Saccharum elephantinus*), Ulnkher (*Imperata cylindrica*) and Hankher (*Pollinia ciliata*) are also found. But the later three species prefer slightly drier soils.

Phragmites karka (Khagori) and Meghela (*Saccharum arundinaceum*) are found in low lying damp areas. On the other hand *Arundo donax* (Nal) is found in the water-logged and marshy places.

The low grasses which are the favourite fodder grasses are found along the open areas around the beels which remain under water during monsoon but dry up during winter. These grasses are *Cynodon dactylon, Chrysopogon aciculatus, Andropogon* spp., *Cenchrus ciliaris.*

In the beels some floating and creeping species are found in the water. These are Dalgrass (*Andropogon* spp.), Erali (*Andropogon* spp.), Kalmou (*Ipomoea reptans*), Helonchi (*Enhydra fluctuans*), Borpuni (*Pistia strafiotes*), Harupuni (*Lemna pancicostata*), Meteka (*Eichhornia* spp.), water hyacinth etc.

Water areas: About 5.58 per cent of the total area of the sanctuary is covered by the beels and streams during the dry months. The area under water is much more during the flood season. This 5.58 per cent represents the area permanently covered by water surfaces. In addition to some grasses these beels teem with fishes of different kinds and sizes providing food for birds and other fish eating animals like otters etc.

CENSUS

The extent of area to be covered, the nature of the terrain and the thick and tall cover of the grasses presented a problem for determining a suitable method of census. Added to these difficulties was the problem of lack of means to traverse the sanctuary except on elephant back. Moreover from experience it was known that preferred habitat of the animals were not evenly distributed all over the sanctuary. As such most of the known methods of taking a sample count had to be discarded. Hence it was decided to take a total count of the animals by dividing the sanctuary into small compartments as was done in 1966.

The whole sanctuary was divided into eight blocks namely Baguri, Haldhibari, Kaziranga, Panbari, Tamulipathar, Boralimora, Charighoria and Bhawani with the help of natural boundaries like rivers, roads and paths etc. The boundary of the blocks and its sizes were kept the same as that of 1966. This was done for the sake of comparability of figures blockwise.

Each of these blocks was subdivided into a number of compartments of 2,000 to 3,000 acres each keeping in view the nature of terrain, density of grass cover, concentration of animals etc. The division of the sanctuary into number of compartments was limited by the number of riding elephants available. With the help of 16 elephants belonging to the sanctuary we could take only 16 compartments for carrying out the census on a single day. Hired elephants were not easily available. However we managed to get four hired elephants. As such the whole sanctuary was divided into 40 compartments with a view to complete the census operation in two days taking 20 compartments on each day. But due to difficulties of moving elephants from one place to another Baguri compartment number I and III had to be combined as one compartment for taking the census. Thus the total number of compartments became 39.

Considering the large concentration of animals the Baguri block was divided into 10 compartments of smaller sizes. On the other hand the compartments of the Bhawani block which consist of short open grasslands due to the presence of graziers and where there is less concentration of animals were slightly bigger than the average compartment.

For the purpose of completing the census in two days the Diflu River was taken as the dividing line. This river flows through the sanctuary from east to west dividing it into two almost equal halves. The river is quite deep with well defined high banks. The chances of animals crossing over from one side of the river to the other during the night was very little. Except for elephants other animals were not expected to cross the river in large numbers so as to affect the results of the census.

It was also assumed that the two way crossings of animals would neutralize the overall effect of the situation. With this view in mind the compartments falling on the southern side of the Diflu River were censused on the 1st day and the compartments falling on the northern side of the river were censused on the 2nd day. There were 21 compartments on the southern side and 18 compartments on the northern side.

The grasslands of the whole sanctuary was then burnt repeatedly and in areas where there were no natural boundaries artificial compartment boundaries of 10 feet width were cut and burnt. But due to intermittent rains, burning was not very successful and thorough all over the sanctuary.

After completion of the field preparations an accurate map of the sanctuary was prepared in $1\frac{1}{2}''$ = 1 mile scale showing the blocks and compartment boundaries, beels, grasslands, tree forests, roads and paths etc. On this map the points from where counting was to be started and the point where counting was to be finished was plotted. The direction of traverse in the various compartments was also plotted keeping in view of the nature of the terrain, grass or tree cover, beels, known points of animal concentration etc. Altogether 39 maps were prepared for use in the 39 compartments.

39 census parties were formed, each party consisting of an enumerator as the incharge, one helper, one guide and a mahout with the elephant. The duty of the enumerator was to count the animals and record the figures as well as to plot the approximate location of the animals and the direction of the line of traverse on the map. The duty of the guide was to see that the census parties remained within the

boundary of their respective compartments. The helper assisted the guide and enumerator in locating the animals. The mahout was engaged in driving the elephants as well as in locating the animals.

The guides and the helpers were selected from the local staff and were posted in their own jurisdiction and therefore had intimate knowledge of the area including the location of favourite grounds of the animals, isolated water holes, wallows, nullahs etc.

In addition to the census parties some patrol parties of three to four persons were formed. They were assigned selected boundaries of blocks and compartments to observe and record the movement of animals from one compartment to other noting the time and approximate place of crossing. However such parties were few and could cover only a negligible portion of some prominent boundaries like roads.

Each census party was assigned one compartment to census. The enumerator was supplied with a copy of the map of Kaziranga Wild Life Sanctuary with the compartment allotted to him prominently demarcated and showing the direction of traverse. Two copies of enumeration forms one for the forenoon and one for the afternoon, a clip board and an appointment letter containing instructions regarding the census operation were also given to the enumerator.

Fifteen species of mammals were listed in the counting sheets. Columns were provided against each species for classifying the animals into two age classes of old and young and for sex differentiation into male and female. A column for recording mother with calf and another column for entering the number of animals as "non sexed" were provided. A remark column was provided for recording interesting behaviour observations or for sightings of animals not listed in the form.

The enumerators were instructed to follow the direction of the traverse as far as practicable depending on field situations. While proceeding along the traverse on the elephants they were to record the number of different kinds of animals sighted. They were instructed not to approach too close to an animal so as to provoke it or frighten it into cover.

Mothers accompanied by calf of one year old or less were to be recorded under the column of mother with calf. Since it might not be possible for the enumerator to know the approximate age of the calf they were instructed that a calf of approximately 2′ to 2′6″ should be considered as one year old.

The guides, helpers and mahouts were trained and tested prior to the commencement of census operation. The enumerators were also trained and given instructions regarding the method of census, procedure to be followed in filling up the forms, different kinds of animals and their general behaviour etc.

Operation:

The census operation was carried out on 24th and 25th March, 1972 in two shifts on each day i.e. from 5.30 a.m. to 10 a.m. in the first shift and 2 p.m. to 5.30 p.m. in the second shift. The elephants along with the mahout, and grass cutters, the guides and the helpers took up positions at their respective starting point of the assigned compartments on the evening of 23rd March. The enumerators were dropped at the starting points by jeep on 24th morning. In places where the jeep could not go the enumerators camped at the starting points on 23rd evening.

The census parties started counting of animals punctually at 5.30 a.m. of 24th March, 1972 setting off from their respective starting point simultaneously in 21 compartments on the southern side of the Diflu River. After completion of the first day's work the enumerators, guides and helpers who were not assigned for duties next day were brought to the camp. The elephants were dispatched to camp at the starting points of next days' compartments on the northern side of the Diflu River. The enumerators, guides and helpers for the count on 25th took up position at their respective starting points on the evening of 24th. Some enumerators were dropped at their respective starting points by jeep on 25th morning. Counting of the animals in the 18 compartments north of the Diflu River also started simultaneously on the 25th at 5.30 a.m. After completion of the day's work some of the enumerators, helpers and guides were picked up by jeep but census parties in areas where the jeep could not go returned to the Range Head Quarters with their elephants the next day, 26th March, 1972.

Most of the rhinos, buffaloes and swamp deer were sighted near and around the beels. The census parties after completion of the counting in the first shift took rest on the banks of the beels.

Since the tendency of the animals was to come to the beels for their afternoon forage the enumerators ruled out any possibility of crossing over of animals from the counted portion of the compartment to the uncounted portion during the rest period. Rhinos are not wanderers and specially during day time prefer to lie down in mud wallows inside the tall grass rather than walk over from one beel to another. The buffaloes and the swamp deer were never seen to go away from the beels which they had selected for the time being. The hog deer population was very numerous and they were encountered everywhere in the sanctuary.

The patrolling parties did not report any incident of crossing over of animals from one compartment to another.

Census parties assigned to compartments consisting mostly of grasslands reported different degrees of burning varying from 30 per cent to 80 per cent. While traversing the census parties avoided the thick patches of unburnt dry grasses. No purpose would have been served by driving the elephant through such tall grasses as the visibility is limited to the portion of the grasses trampled by the elephant and no animal generally prefers such areas excepting an occasional rhino passing through tunnels in the grass. Most of the mud wallows were also dry at this time of the year. Almost all traverses were taken along the burnt patches and open beels and most of the animals were sighted in such areas only. Thus although the area covered during the census was approximately 60 per cent to 70 per cent almost all the animals were covered by the count.

In the compartments consisting mainly of evergreen tree forests the census parties could traverse only areas in which the undergrowth was not very thick. In certain compartments the undergrowth was so thick that many such areas were impenetrable. The heavy cane growth in such forests presented another difficulty. These forests held sambar, barking deer, bear, langur, elephant, tiger etc. There were a number of rhinos also near the beels. Only approximately 40 per cent to 50 per cent of such animals living in them were counted.

Effectiveness of the census Method:

The method of census employed for counting the animals gave us figures of only the total minimum population of the species inhabiting the area actually covered during census. Since visual counting of animals in dense forests is difficult the method is ineffective for counting animals in dense cover. Similarly nocturnal animals cannot be effectively counted by this method. A drawback detected while analysing the results of the census was that the counting sheets provided no columns to classify the animals into different age groups of adult and young in case of the non-sexed animals. As such the proportion of adult and young animals in the various populations could not be found out correctly.

The census parties found it difficult in the field to differentiate between the adults and the young of the species accurately. All the grown up looking animals including the old ones were classified as adults. There was no difficulty in classifying the comparatively younger looking animals. All the rhinos with undeveloped horns and having smaller horns were classified as young. The confusion was so great in case of other animals that the census parties did not try to classify the age groups at all. This is again due to lack of experience of the census parties and our failure to give them adequate instructions and a criterion to differentiate the age group of the different species.

Similarly the census parties found it difficult to identify the sex of the animals accurately. In case of rhinos it was much more difficult as the males and females of the species look alike. But as the main emphasis during the census was given to the rhinos the enumerators tried their best to identify the sex of the rhinos. The experienced staff of the sanctuary and the mahouts claim to be able to identify the sex of the rhinos on the basis of size and the shape of the horn and the neck. Some of them were tested from time to time and their identification of sex were found to be fairly accurate. Sometimes the enumerators consulted the guide, helper and the mahout in identifying the sex.

In case of elephants also the same confusion was present. Moreover as the elephants are met in large herds and it was difficult to make a close approach the idea of identifying the sex of the elephants was given up. It was easy to identify the sex of the buffaloes. But the problem was that on closer approach the buffaloes ran for cover. So also was the case with the deer species, the antlers of most of them being in velvet at that time. The number of hog deer were found so numerous running from one cover to the other that the census parties gave up their effort to identify their sex. A great deal of difficulty in this respect could have been overcome if the census parties could have been provided with field glasses.

As a result of these difficulties the age and sex composition of the animals except that of the rhinos could not be collected from the census operation.. The census has thus partially failed to achieve the desired objectives. The age and sex composition of a population indicates the status of the species in a given locality. A population well represented by young is a viable and dynamic population where as proportionately higher number of adults with very few young represents a static and senile population.

Thus the result obtained from this census has given us only the basic information regarding the size of the population of various species without throwing any light on the factors governing population dynamics. However the figures have given us enough data for planning the future management of the sanctuary.

Check census:

After completion of the census operation on the 24, 25 March, 1972 it was proposed to check the data collected by repeating the operation in Baguri block on 8 April, 1972.

The reason for selecting the Baguri block for this purpose was the fact that this block had the highest concentration of animals. But due to heavy and continuous rain this could not be done on the appointed day.

Due to various difficulties it was later on decided to carry out the check census at least in one compartment of each block selected at random. This was carried out on June, 1972 in three compartments of the Baguri block and one compartment in each of the remaining blocks.

The grasses had shot up by this time and probably the animals had also changed their places of grazing. Though there was appreciable difference in time, weather, temperature, vegetational cover etc. between the original census and the check census the figures obtained for the different compartments do not show any appreciable variation in the number of the various species, suggesting that the earlier figures are reliable.

Population Estimates:

With a view to present the figures of the census conveniently in round figures to visitors the estimated total population of each species has been shown. These estimates are based on local experience and knowledge.

RESULTS

The census figures have revealed an overall increase of population of all species of animals. Only in case of sambar the number of animals sighted during this year is slightly less than the number sighted during 1966. This is due to the fact that the compartments consisting of dense forests could not be thoroughly covered. The number of different species of animals counted in the various compartments and blocks are given in Table 1.

A comparative statement showing the figures of 1966 census and that of the 1972 census along with the total estimated population is given in Table 2. It would not be correct to attribute the increase or decrease of the animals sighted during this year entirely due to increase or decrease of population over the period of six years. The increase is probably due to more intensive coverage of the area during this years' census in addition to the natural increase of population. Similarly the decreased number of sighting of sambar during this year is due to the fact that its habitat was not as intensively covered as in 1966. The fall does not represent a decrease of population for the reason that the method of census employed does not provide us a comparable base of the total population of the area. Specially be-

TABLE 1

COMPARTMENTWISE FIGURES OF WILD ANIMALS IN THE KAZIRANGA WILD LIFE SANCTUARY DURING MARCH 1972.

Name of Block	Compartment No.	Rhino	Elephant	Buffalo	Tiger	Swamp Deer	Sambar	Barking Deer	Hog Deer	Bear	Gaur	Leopard	Pig	Capped Langur	Otter	Assam Rhesus	Monitor Lizard	Python	Water monitor Lizard
Baguri	I & III	35	3	15	—	1	—	2	175	2	—	—	33	—	—	—	—	—	—
	II	29	—	54	—	—	—	2	312	—	—	—	85	25	—	—	—	—	—
	IV	55	—	49	—	—	—	—	95	—	—	—	12	—	—	—	—	—	—
	V	34	—	48	—	—	—	—	60	—	—	—	2	—	—	—	—	—	—
	VI	40	—	90	—	47	6	—	78	—	—	—	14	—	3	—	—	—	—
	VII	21	—	29	1	17	—	—	106	—	—	—	1	—	7	—	—	—	—
	VIII	11	—	6	—	—	15	—	35	—	—	—	16	—	10	—	—	—	—
	IX	12	—	16	—	—	2	2	35	—	—	—	4	—	11	—	—	—	—
	X	49	1	9	—	—	—	—	109	1	—	—	18	—	5	—	—	—	—
	XI	23	9	2	—	58	—	—	182	—	—	—	11	—	10	—	—	—	—
Total:		309	13	318	1	123	23	6	1,187	3	—	—	196	25	46	—	—	—	—

TABLE 1 (contd.)

COMPARTMENTWISE FIGURES OF WILD ANIMALS IN THE KAZIRANGA WILD LIFE SANCTUARY DURING MARCH 1972.

Name of Block	Compartment No.	Rhino	Elephant	Buffalo	Tiger	Swamp Deer	Sambar	Barking Deer	Hog Deer	Bear	Gaur	Leopard	Pig	Capped Langur	Otter	Assam Rhesus	Monitor Lizard	Python	Water monitor Lizard
Haldhibari	I	6	—	2	—	—	—	—	5	—	—	—	9	—	—	4	—	—	—
	II	18	—	45	—	14	—	—	22	—	—	—	19	—	—	—	—	—	—
	III	50	—	32	1	31	—	13	278	—	—	—	6	—	—	2	—	—	—
	IV	32	—	35	1	9	14	3	350	—	—	—	67	—	7	—	2	—	—
Total:		106	—	114	2	54	14	16	655	—	—	—	101	—	7	6	2	—	—
Kaziranga	I	18	1	—	—	—	—	—	28	—	—	—	26	—	—	—	—	—	—
	II	2	—	12	—	—	—	—	9	—	—	—	7	—	—	—	—	—	—
	III	13	31	—	—	62	—	3	20	—	—	—	3	—	—	—	—	—	—
	IV	1	1	1	—	10	—	5	59	—	—	—	10	—	9	—	—	—	—
Total:		34	33	13	—	72	—	8	116	—	—	—	46	—	9	—	—	—	—

TABLE 1 (contd.)

COMPARTMENTWISE FIGURES OF WILD ANIMALS IN THE KAZIRANGA WILD LIFE SANCTUARY DURING MARCH 1972.

Name of Block	Compartment No.	Rhino	Elephant	Buffalo	Tiger	Swamp Deer	Sambar	Barking Deer	Hog Deer	Bear	Gaur	Leopard	Pig	Capped Langur	Otter	Assam Rhesus	Monitor Lizard	Python	Water monitor Lizard
Panbari	I	19	5	28	2	66	7	2	448	2	—	1	9	—	—	—	—	—	—
	II	25	1	8	—	10	—	1	310	—	—	—	34	—	—	—	—	2	—
	III	9	3	—	—	35	13	—	67	—	—	—	4	—	—	—	—	—	—
	IV	3	1	—	—	—	—	—	5	—	—	—	2	—	—	—	—	—	—
	V	8	15	—	—	—	1	4	52	—	—	—	3	—	—	—	—	—	—
Total:		64	25	36	2	111	21	7	882	2	—	1	52	—	—	—	—	2	—
Tamulipathar	I	5	19	1	—	9	—	—	81	—	—	—	9	—	—	—	—	—	—
	II	4	23	14	—	—	—	—	22	—	—	—	—	—	—	—	—	—	—
	III	7	95	—	—	—	1	15	50	—	—	—	7	—	—	—	—	—	—
Total:		16	137	15	—	9	1	15	153	—	—	—	16	—	—	—	—	—	—

TABLE 1 (contd.)

COMPARTMENTWISE FIGURES OF WILD ANIMALS IN THE KAZIRANGA WILD LIFE SANCTUARY DURING MARCH 1972.

Name of Block	Compartment No.	Rhino	Elephant	Buffalo	Tiger	Swamp Deer	Sambar	Barking Deer	Hog Deer	Bear	Gaur	Leopard	Pig	Capped Langur	Otter	Assam Rhesus	Monitor Lizard	Python	Water monitor Lizard
Boralimora	I	6	6	28	2	—	11	—	44	—	—	—	23	—	20	—	—	—	—
	II	2	—	—	—	—	3	—	37	—	—	—	—	—	—	—	—	—	—
	III	1	1	—	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—
	IV	5	2	—	—	29	5	2	—	—	12	—	3	—	—	—	—	—	—
Total:		14	9	28	2	29	19	2	86	—	12	—	26	—	20	—	—	—	—
Charighoria	I	12	—	—	—	15	—	—	244	—	1	—	—	—	7	—	—	—	—
	II	10	—	—	—	36	13	1	230	—	—	—	6	—	—	—	—	1	—
	III	6	162	—	—	—	3	13	40	—	—	—	3	—	—	—	—	—	—
	IV	22	30	13	—	—	1	—	48	1	5	—	14	—	—	—	1	—	1
	V	10	1	—	—	1	2	—	126	—	—	—	3	—	6	—	—	—	—
Total:		60	193	13	—	52	19	14	688	1	6	—	26	—	13	—	1	1	1

TABLE 1 (contd.)

COMPARTMENTWISE FIGURES OF WILD ANIMALS IN THE KAZIRANGA WILD LIFE SANCTUARY DURING MARCH 1972.

Name of Block	Compartment No.	Rhino	Elephant	Buffalo	Tiger	Swamp Deer	Sambar	Barking Deer	Hog Deer	Bear	Gaur	Leopard	Pig	Capped Langur	Otter	Assam Rhesus	Monitor Lizard	Python	Water monitor Lizard
Bhawani	I	1	1	4	—	4	—	—	446	—	—	—	1	—	—	—	—	—	—
	II	7	1	3	—	—	1	—	199	—	—	—	43	—	—	—	—	—	—
	III	29	8	11	—	41	4	—	61	—	—	—	12	—	—	—	—	—	—
	IV	18	2	—	—	21	3	8	78	—	—	—	3	—	—	—	—	—	—
Total:		55	12	18	—	66	8	8	784	—	—	—	59	—	—	—	—	—	—
Grand Total:		658	422	555	7	516	105	76	4,551	6	18	1	522	25	95	6	3	3	1

TABLE 2

COMPARATIVE FIGURES OF 1966 AND 1972 CENSUS AND THE ESTIMATED POPULATION

Species	Year	Baguri	Haldhibari	Kaziranga	Panbari	Tamulipathar	Boralimora	Charighoria	Bhawani	Total	Estimated Total
Rhino	1966	157	49	32	30	9	8	22	59	366	400
	1972	309	106	34	64	16	14	60	55	658	670
Elephant	1966	45	–	29	7	6	5	–	257	349	375
	1972	13	–	33	25	137	9	193	12	422	430
Wild Buffalo	1966	337	41	33	17	30	–	17	6	471	550
	1972	318	114	13	36	15	28	13	18	555	600
Gaur	1966	–	–	–	–	–	–	1	–	1	20
	1972	–	–	–	–	–	12	6	–	18	18
Swamp Deer	1966	72	25	16	19	–	11	19	1	213	250
	1972	123	54	72	111	9	29	52	66	516	520
Sambar	1966	43	8	1	1	3	1	2	61	120	300
	1972	23	14	–	21	1	19	19	8	105	200
Hog Deer	1966	485	77	95	122	22	5	223	282	1311	4000–5000
	1972	187	655	116	882	153	86	688	784	4551	6000–6050
Barking deer	1966	12	10	–	7	–	–	–	–	29	100
	1972	6	16	8	7	15	2	14	8	76	100
Wild Pig	1966	45	29	33	18	10	10	10	–	155	500–600
	1972	196	101	46	52	16	26	26	59	522	550–650
Bear	1966	1	–	1	–	–	–	–	–	2	30
	1972	3	–	–	2	–	–	1	–	6	30
Tiger	1966	–	1	–	–	–	–	–	1	2	20
	1972	1	2	–	2		2	–	–	7	30
Leopard	1966	–	–	1	–	–	–	–	–	1	12
	1972	–	–	–	1	–	–	–	–	1	10
Otter	1966	7	9	–	1	–	–	8	1	26	200–300
	1972	46	7	9	–	–	20	13	–	95	200–300

TABLE 3

COMPARATIVE FIGURES OF MAIN AND CHECK CENSUS

Name of Block	Compartment No.	Rhino										Elephant		Buffalo		Swamp deer	
		Original Census					Check Census										
		♂	♀	Mother & calf	Nonsexed	Total	♂	♀	Mother & Calf	Nonsexed	Total	Original Census	Check census	Original census	Check census	Original census	Check census
Baguri	IV	15	13	6	15	55	20	—	15	—	50	—	—	49	63	—	10
,,	VII	8	8	—	5	21	8	7	1	1	18	—	—	29	47	17	—
,,	XI	9	4	5	—	23	13	7	—	—	20	9	—	2	27	58	—
Haldhibari	III	13	12	2	21	50	25	18	8	—	59	—	—	32	36	31	56
Kaziranga	II	1	—	—	1	2	10	15	4	—	33	—	—	12	15	—	32
Panbari	I	8	1	3	4	19	9	8	2	—	21	5	—	28	—	66	44
Tamulipathar	II	2	—	1	—	4	1	—	—	—	1	23	2	14	7	—	—
Boralimora	I	3	3	—	—	6	1	1	—	—	2	6	18	28	1	11	—
Charighoria	III	1	1	1	2	6	10	1	3	—	17	162	—	—	—	3	—
Bhawani	IV	6	4	4	—	18	3	2	1	1	8	2	62	—	4	21	25
Total:		66	46	22	48	204	100	59	34	2	229	207	82	194	200	207	167

cause of the wide gap of six years between the two census operations. As such probably it would not be wise to draw any conclusion from these comparisons. Perhaps intensive repeated annual counts of the total minimum population or repeated annual sample counts over a considerable period may provide us comparable data to enable us to derive some conclusion regarding the factors governing the population.

In Table 3 the comparative figures of this years' census and that of the check census carried out later in the month of June are given. There was no difference between these two censuses as regards level of efficiency, intensity of area covered etc. except the interval of time, change of weather and vegetation. The number of rhinos counted during the check census was 12.2 per cent more than the original census. In case of elephants it was 60.4 per cent less, in case of buffaloes it was 3.1 per cent more and in case of swamp deer it was 19.3 per cent less. The large variation in case of elephants can be easily understood from the fact that they are great wanderers and are constantly on the move while grazing. The check census show that the figures obtained during the main census operation are authentic as the variation in case of other animals is insignificant.

Analysis of census data:

1. **Rhinoceros**

A total of 658 rhinos were counted during the census operation. Out of these 203 were classified as adult males, 121 as adult females, 44 as young males, 37 as young females, 119 as non sexed and 67 mothers with calves. These 67 mothers have not been included in the number of 121 adult females. The figures for rhinos are given in Table 4.

TABLE 4

Name of Block	Adult		Young		Nonsexed	Mother with calf	Total
	♂	♀	♂	♀			
Baguri	98	51	17	19	54	35	309
Haldhibari	30	23	3	5	31	7	106
Kaziranga	14	4	9	–	1	3	34
Tamulipathar	5	3	–	1	3	2	16
Panbari	19	7	5	3	16	7	64
Boralimora	6	3	–	–	3	1	14
Charighoria	13	11	5	6	11	7	60
Bhawani	18	19	5	3	–	5	55
Total:	203	121	44	37	119	67	658

The confusion in determining the sex of the rhinos occured mostly in case of the young ones where the horn was not properly developed. As such most of the nonsexed animals may be considered to be young ones. On this assumption the age composition of the population will be 59.4 per cent adult, 30.4 per cent young and 10.2 per cent calves less than one year old. As stated earlier only comparatively younger looking animals were classified as young. Considering the fact that the rhinos live up to an approximate average age of 40 years probably many young animals were included in the adult group.

Out of the total count of 658 rhinos 472 were classified into males and females. Of the entire adult population of 391 rhinos, 203 are classified as males and 188 as females (including the 67 mothers). The sex ratio in the adult population thus works out to 100 males for 92 females.

In case of 81 young rhinos of whose sex was identified 44 have been recorded as males against 37 females. The sex ratio in the young population thus works out to 100 males for 84 females.

In the check census out of a total count of 229 rhinos 100 were classified as males, 93 as females, 34 calves and 2 were nonsexed. Here also the sex ratio comes out to 100 males for 93 females. Thus we can roughly estimate that the males and females in a population are equally distributed with the sex ratio of one is to one.

But considering the fact that an adult female rhino gives birth to a calf after every three to four years after a gestation period of 16 to 18 months it is apparent that in any particular time of the year there will be a group of pregnant adult females, females with less than one year old calf and females with 2 year old calf who will not go into heat and will not accept the services of any male. Hence the sex ratio of one is to one appears to be unlikely. Probably the disparity in the sex ratio can be explained to some extent by the fact that for successful mating of rhinos the heat period of both the male and the female must coincide.

In a population of 658 rhinos there were 67 adult females with calves less than one year old. That is 10.2 per cent of the total population were calves less than one year old representing the annual rate of calving. Again out of 188 adult females 67 were with calves. That is 35.6 per cent of the total adult female population were accompanied by calves.

It is not difficult to differentiate between one year old and two year old calves in the field. Yet possibility of error in some marginal cases cannot be ruled out. The calves generally accompany the mother up to 3 years and in some cases till the next calf is born. But the behaviour of a very young calf and its mother and that of a grown up calf and its mother are quite different and can be easily distinguished.

The following table gives us the record of death of rhinos in Kaziranga Wild Life Sanctuary over a period of seven years.

TABLE 5

Year	Natural death				Killed by poachers				Killed by tigers				Total
	Adult		Young		Adult		Young		Adult		Young		
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	
1965	10	9	–	–	14	4	–	–	–	–	4	2	43
1966	4	5	–	–	2	3	–	–	–	–	1	1	16
1967	10	13	–	–	6	4	1	1	–	–	2	2	39
1968	5	7	–	–	7	3	–	–	–	–	8	3	33
1969	9	3	–	–	1	–	2	5	–	–	2	1	23
1970	12	8	–	–	2	–	–	–	–	–	4	2	28
1971	8	5	–	–	4	2	1	1	–	–	6	1	28
Total:	58	50	–	–	36	16	4	7	–	–	27	12	210

From the figures for the last seven years the average mortality of rhinos is 30 annually which is 4.6 per cent of the total rhinos counted during this year. On the basis of these figures the annual rate of growth of rhino population in Kaziranga comes to 37 which is 5.6 per cent of the population.

From this table it appears that most of the deaths amongst young rhinos are caused by tiger. Approximately 6 young rhinos die annually due to tiger attack. The number of natural deaths amongst the adult population are due to old age and fighting. Thus in an average approximately 16 rhinos die of old age and fighting etc. The annual mortality rate is considerably affected by poaching.

Rhinos were found in all the compartments of the sanctuary. The Baguri block was found to have the maximum concentration of rhinos. As many as 309 rhinos out of a total of 658 rhinos were counted in Baguri block only. The reasons for such concentration requires detailed investigation. It is true of course that the area of the Baguri block was bigger than any other block. The following table gives the area in acres available per rhino in each of the eight blocks.

TABLE 6

Name of Block	Total Area in acres	Number of rhinos counted.	Approximate Area available per rhino in acres.
Baguri	17,000.24	309	55.0
Haldhibari	9,809.72	106	92.5
Kaziranga	11,046.30	34	324.5
Panbari	10,819.54	64	169.0
Tamulipathar	9,919.00	16	620.0
Boralimora	8,458.40	14	604.0
Charighoria	12,336.86	60	205.6
Bhawani	14,229.84	55	258.7
Total:	93,619.90	658	142.2 (Ave.)

Thus it is seen that in Baguri block there is one rhino in every 55 acres against 1 rhino in every 142.2 acres for the whole sanctuary. The nature of vegetation and availability of fodder grasses in the remaining parts of the Sanctuary have no appreciable difference with that of Baguri block. The only difference is the fact that the number of beels and the area under water in Baguri block is more than in any of the remaining blocks of the Sanctuary.

The rhinos in Baguri block as well as in the rest of the sanctuary were found in excellent health. Hence it can be safely assumed that the population of rhinos in the Sanctuary has not yet reached the saturation point. This is also indicated by the presence of vast areas of unused grasslands in the Sanctuary.

As a result of increase in population gradual diffusion of rhinos along the bank of the Brahmaputra River to the river islands and other suitable forested areas have started as a natural process. But due to the high value of the horn such animals are not safe in isolated areas where effective protection cannot be given. Till the rhinos establish themselves and build up sizable population in such areas the species cannot be considered as free from the danger of extinction. With more than half of the world's surviving population of Great Indian Onehorned Rhinoceros concentrated in one place, Kaziranga has a special and unique role to play.

Wild Elephants:

A total of 422 elephants were counted during the census. They were mostly met in herds of varying sizes except a few solitary males. Out of the 39 compartments of the Sanctuary, elephants were met in 24. Most of them were found in the eastern part of the Sanctuary.

The elephant population of the sanctuary does not remain static throughout the year. Some of them migrate to the adjoining Mikir hills on the southern side of the boundary during the rainy season. The to and fro movement of the elephants from the Sanctuary to the Mikir hills take place generally at two different places. One is through the Panbari Reserved Forests situated midway in the southern boundary of the sanctuary across the National highway. The other is near Kanchanjuri on the western end of the sanctuary. Some elephants use the corridor through Haldhibari also.

But such migration of elephants have been greatly reduced during the recent years due to the opening up of the valley lands and the lower hills for cultivation. The tribal population of Mikir hills have started cutting and burning large areas of forests even on steep hills. As a result there are large scale depredation by elephants all along the foot hills as well as along the southern boundary of the sanctuary during the crop season. These elephants then retreat to the sanctuary when driven away. Thus a gradual decrease of habitat in the hills and widening of the gap between the sanctuary and the nearby hills by human settlement will in time force the elephants of the sanctuary to remain within it.

There is no corridor for the elephants to cross over to Mikir hills in the eastern part of the sanctuary. The presence of a large number of elephants in the eastern part of the sanctuary suggest that these elephants have probably already given up the habit of going back to the hills. The elephants are of course great wanderers and are constantly on the move while grazing and the possibility of these elephants coming to cross over through Panbari reserve cannot be ruled out.

Probably the elephant population accounts for the largest contribution to the biomass of the sanctuary. The elephant population needs to be watched carefully because of its wandering habits, the amount of food consumed and the amount of destruction it causes to the habitat. The elephant has the highest reach of any terrestrial mammal in the country. Therefore it can utilize both forested areas and the grasslands for foraging. Though elephants were met in 24 compartments only at the time of census actually they traverse almost all the compartments of the sanctuary at one time or the other.

Wild Buffalo

In the sanctuary wild buffaloes are found grazing around the beels in the morning and afternoon. During day time they are found lying in the mud wallows. Except in case of solitary males they are always in herds of varying sizes. The herds generally consist of one dominant adult male, immature males and cows of all ages. The social grouping of buffalo is quite cohesive and the most cohesive unit is the cow herd with calves. The immature males may form small sub-groups and the dominant males may wander about in the vicinity.

During the census 555 buffaloes were counted in the sanctuary. They were found in 27 compartments leaving only 12 compartments without any of them. The highest number of buffaloes were counted in the Baguri block (318 individuals).

Though it was not difficult to identify the age groups, count the calves, and identify the sex of the buffaloes the same was not done by most of the census parties due to some reason or the other. However during individual interrogation the census party reported that calves were well represented in the herds. From field observations also I have noticed that an average herd of 10 to 12 buffaloes always included 3 to 5 calves.

Swamp Deer

In olden days the swamp deer was found in suitable localities throughout the basins of the Indus, Ganges and the Brahmaputra Rivers as well as in central India. But today the swamp deer exists only in a few isolated pockets. The main centres of its survival at present are in West Kheri Forest Division of U.P. and its adjoining areas in Nepal, Kanha National Park of M.P. and in scattered places of North Bengal and Assam. Schaller estimates that fewer than 5,000 swamp deer exist in the whole country.

Probably the largest number of surviving swamp deer in the eastern zone at present exist only in Kaziranga Wild Life Sanctuary. During the census 516 swamp deer were counted in the sanctuary against 213 counted during 1966. Nineteen out of the 39 compartments reported no swamp deer. The highest number was recorded in Baguri block. The largest single herd encountered during the census consisted of 58 individuals.

The swamp deer population inside the sanctuary are always found in herds grazing or lying down in the open grassland around the beels. The males were congregated in a separate subgroup in the same herd. At the time of census the antlers of the males were in velvet.

Sambar

In Kaziranga the sambar is distributed only in the heavily wooded compartments. They are usually solitary animals except in case of small social groups of a hind, an yearling and a fawn. Sometimes 2 to 3 adult hinds accompanied by fawns, yearling stags etc. may be found to form bigger herds. The adult stags are solitary except in the rutting season.

During the census 105 sambar were sighted against 120 sighted during 1966. Out of total 39 compartments 21 compartments reported no sambar. As stated earlier the forested compartments of the sanctuary could not be covered intensively due to the presence of thick undergrowth and cane brakes. This explains the low figure of sighting of these animals. There is no apparent reason to suspect that there is any decline in the population of sambar in the sanctuary.

Hog Deer

Hog deer tops the list in numerical density among all other animals of the sanctuary. They were scattered everywhere in the sanctuary and were too numerous to be counted accurately. Though usually they do not form cohesive herds sometimes groups of hog deer consisting of 50 to 60 individuals were found together, sometimes in smaller groups of 3 to 5 individuals and sometimes solitary males or females with a fawn or an yearling were also found. At the time of census some stags had hard antlers and some were in velvet.

During the census 4,551 hog deer were counted. It was difficult to see them when they were under grass cover or when they rushed into such cover at the sight or sound of the riding elephants. Only one compartment reported no hog deer. It is certain that quite a good number of them were missed.

Judging from their excellent condition and the presence of fawns and yearlings in the groups observed during field investigation probably it can be safely concluded that the population has not yet reached its peak in the Sanctuary.

Barking Deer

The barking deer or the muntjac also prefers the same habitat as that of the sambar. Due to their small size and the forested habitat it was difficult to locate and count them accurately. Only 76 barking deer were counted during the census in 15 out of 39 compartments.

Wild Boar

The wild boar was common in many parts of the sanctuary. They are commonly sighted around the beels as well as in the heavily forested areas. They seem to avoid the tall reed grasses. Except in case of solitary males they are found in family groups of 4 to 6 individuals. Their shy nature and relatively small size make it difficult to locate and count them accurately.

During the census 522 pigs were counted against 155 counted during 1966. Pigs were sighted in 35 out of 39 compartments of the sanctuary. This distribution itself suggested that probably only a small portion of their total population could be counted during the census.

Gaur

Three census parties reported sighting of the gaur on the second day of the census. No gaur was sighted by any of our sanctuary staff during the last four years. The gaur are actually not residents of the sanctuary. They come to the sanctuary from the Mikir hills during winter when large scale felling and burning for jhum cultivation takes place in the hills. It was thought that due to gradual opening up of the forests in the foothills and widening of the gap between the Sanctuary and the hills by human settlement the gaur have gone to the interior hills never to visit the sanctuary again. However judging from the point of location of these animals it appears that the gaur sighted during the census are permanent residents of the sanctuary.

Altogether 18 gaur were sighted in Boralimora and Charighoria blocks. One was a solitary male in one compartment, 5 in a herd in one compartment and a herd of 12 in another compartment.

Tiger

Seven tigers were sighted by the census parties. But it is apparent that this method of census cannot be employed to count an animal like tiger which is nocturnal in its habits and is extremely alert and shy. However the sighting of as many as 7 tigers is quite significant and is an indication of its relative numerical strength in the Sanctuary.

A separate census for counting the tigers in Kaziranga along with the rest of the state and the country was conducted from 22nd April to 28th April 1972 by Chowdhury's "Tiger tracer" method. The total number of tigers counted by this method in the sanctuary was 29. Out of these 29 tigers 9 were male, 13 female and 7 cubs. During the period of this census there was very heavy rains in this area submerging most of the low lying areas around the beels. As a result the census could not be carried out as effectively as planned. Probably quite a few tigers missed the count. Co-ordinators working on this census have reported definite missing of some known tigers in certain parts of the sanctuary. It is planned to repeat the census during the next winter.

Leopard

Only one leopard was sighted in the sanctuary near Panbari Reserved Forests. There are no leopards in the interior parts of the sanctuary. Only a few leopards probably stay in the periphery of the sanctuary adjoining the villages. But they are quite common in the foot of the nearby Mikir hills where they are heard to call at night and often seen also. There are some leopards even near the Tourist Lodge.

Other animals

Other animals recorded during the census are sloth bear, otters, capped langurs etc.

Though bears are common in certain parts of the sanctuary in wooded areas near Kanchanjuri, Bimoli, Kathpara etc. only 6 of them were seen during the census. This is due to the type of forests where they live during the day time and due to their nocturnal habits.

Otters in large family groups are common in almost all the beels of the sanctuary. The otters usually escaped the notice of the census parties and the number recorded were only the results of sighting. 95 otters were counted during the census.

Langurs and macaques are found in the wooded areas in the periphery of the sanctuary. During the census 25 capped langurs and 6 rhesus monkeys have been recorded. Probably many were missed.

The recorded figures for common lizards, water monitor lizards, pythons, hog badgers are insignificant.

Some census parties have recorded figures of sighting barheaded geese, pelicans etc.

Concentration of animals:

The Baguri block situated on the western end of the sanctuary has the maximum concentration of almost all the animals. 46.9 per cent rhinos, 3.08 per cent elephants, 57.3 per cent buffaloes, 23.7 per cent swamp deer, 21.9 per cent sambar, 26.08 per cent hog deer, 7.89 per cent barking deer and 37.54 per cent wild boar of the total number of animals counted were found in this block. The total area of this block is 17,000.24 acres or 68.79 sq kms representing 18.15 per cent or roughly 1/5th of the total area of the sanctuary. The density of different species of animals in this block works out to 4.49 rhino, 0.18 elephant, 4.6 buffalo, 1.79 swamp deer, 0.33 sambar, 17.4 hog deer, 0.08 barking deer and 2.84 wild boar per sq km. Though the numerical density of various species of animals was so high the habitat as a whole in this block did not appear to be overused. There was lush green grass everywhere and the animals observed were in excellent health.

Against this density in Baguri block the density of various animals in remaining parts of the sanctuary comprising an area of 310.07 hectares representing 81.85 per cent or roughly 4/5th of the sanctuary works out to 1.01 rhino, 1.31 elephant, 0.76 buffalo, 1.26 swamp deer, 0.26 sambar, 1.84 hog deer, 0.22 barking deer and 1.05 wild boar per sq km. There seems to be no competition amongst the different kinds of herbivorous animals at present even in the Baguri block due to the availability of adequate quantity of fodder. Areas where rhinos, swamp deer, hog deer and buffaloes are seen grazing together are full of green grass. The hog deer population is widely distributed and their grazing grounds are not confined to the beels. So also is the case with the buffalo.

Taking all these factors into consideration it can be safely concluded that the sanctuary is not overcrowded and it has the capacity to support a much bigger biomass than the present one.

Distribution of animals:

It is not understood why the Baguri block is favoured and preferred by most of the animals even though the range conditions of this block and the rest of the sanctuary have no apparent difference. The vegetational cover is almost the same all over. Though the area under beels are highest in Baguri block, water is not a limiting factor in any of the remaining blocks of the sanctuary. The only difference observed was that the intensity of burning is less in Tamulipathar, Boralimora and Panbari blocks where large areas remained covered with tall grasses. The second difference is that these tall and thick mass of reeds in these areas grow almost upto the banks of the beels leaving very little area of shorter grasses like *Chrysopogon aciculatus, Cynodon dactylon, Andropogon* spp. around the beels. The third difference is the fact that the Baguri block is nearer to the adjacent Mikir hills and provides a corridor to the animals to cross over to these hills during high floods, in two places. To what extent these factors or any other unknown factor influence the concentration of animals is to be studied further.

From wild life management point of view such heavy concentration of animals are not desirable specially in the present condition when poaching is a major factor. Moreover Baguri block is in the extreme western end of the sanctuary from where the animals may go out of the sanctuary to raid crops of villagers and expose themselves to the danger of poaching. Steps must be taken to disperse these animals into the remaining parts of the sanctuary by providing artificial salt licks, improvement of range conditions and grazing grounds.

RECOMMENDATIONS

Fodder grasses:

Most of the animals prefer shorter grasses growing around the beels and other open areas. The tender shoots of the reeds coming out immediately after burning are also relished by the animals. But as the reeds grow taller shooting upto a height of 10 to 15 feet they go out of the reach of the rhinos, hog deer, swamp deer etc. The reeds dry up during the winter and provide no food for the animals except the elephants. The major portion of the sanctuary's grasslands consist of such tall reeds. Some of these reeds around the vicinity of the beels should be replaced by shorter edible fodder grasses mentioned earlier.

Annual control burning to reduce the density of the thick reeds are to be continued.

Flood and Erosion:

Though flood is essential for maintaining the habitat and clearance of water hyacinth it must not be allowed to go out of hand. Some of the sanctuary's channels and outlets for flood water which have since silted up need to be renovated.

The large scale migration of animals from the sanctuary to the adjacent hills during high floods should be brought down to the minimum. To provide shelter to the marooned animals during flood high grounds should be created within the sanctuary. This can be done by raising the levels of the existing roads near the beels. If the roads are widened and raised near the beels it will not only provide shelter for the animals during flood but will also enable the visitors during winter to observe the animals grazing around the beels from their motor cars. In the meantime the proposal already initiated to include a portion of the Mikir hills into the sanctuary should be speeded up.

Instead of depending on the annual flood to wash away the water hyacinth some other mechanical device should be provided to clear them. Moreover it must be mentioned here that flood of lower intensity cannot clear the water hyacinth as seen during the last year.

As stated already the erosion of the sanctuary has greatly reduced its area. As such effective steps require to be taken up to halt this process by erecting spurs and dykes in suitable places.

Scientific research:

Research to collect some of the basic data like population dynamics, reproductive behaviour, food habits etc. of the various species of animals should be carried out, the ecology of the habitat should be studied. Census of animals should be carried out annually.

Financial Aspects:

Instead of continuing as a burden to the state treasury Kaziranga has the potential to become a major source of revenue for the state, specially much needed foreign exchange. To achieve this objective some imaginative measures are to be taken. But this is outside the purview of this report.

However it is suggested that some rhinos may be captured and sold to foreign and Indian Zoos of repute whenever such demands are received. It is also suggested that to keep the population of elephants under control as well as to reduce the depredation of wild elephants in the surrounding villages some elephants should also be captured in and around the sanctuary under direct departmental supervision on an experimental basis. The elephants thus captured may be sold to outside agencies or may be used for tourists and visitors.

Expenditure:

The total expenditure incurred during the whole census operation amounted to Rs. 2,594.87 paise only (Rupees two thousand five hundred ninetyfour and paise eightyseven only). The break up figure is as follows:

Elephant hire charges	: Rs. 1,020.00
Cost of cutting Compartment lines	: Rs. 812.00
Miscellaneous contingencies	: Rs. 762.87
Total	: Rs. 2,594.87

One rhino horn weighing 1.139 kg was recovered while cutting Compartment lines. The value of the horn is about Rs. 11,000/- (Rupees eleven thousand only). Thus the expenditure incurred for the census operation have yielded not only much information but have also yielded some revenue after covering the whole expenditure.

Dry Evergreen Forest of Point Calimere and Marakanam[1]

BY

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(*With three plates*)

The "tropical dry evergreen forests" have been distinguished by several authors, notably by Champion (1936); they represent a peculiar type that is confined to Northern Ceylon and to the coastal regions of Coromandel.

In Ceylon, this group comprises dense formations that constitute true forests. In India, these formations are essentially thickets, more or less dense, well characterised in the littoral reserved forests of the Bay of Bengal, notably in Point Calimere and Marakanam. For the latter region there exist some publications concerning forestry and ecology (Krishnan 1940; Dabholkar 1962; Legris 1963; Krishnan 1971) or history and zoology (Daniel 1967), but no detailed study on ecology, physiognomy or dynamism seems to have been done so far in these regions. Therefore, our investigations deal with these points essentially.

ECOLOGY

Four principal ecological factors should be considered: rainfall, duration of dry seasons, seasonal variations of temperature and finally, physical properties of soils.

The temperature varies very slightly from locality to locality and from season to season at these latitudes of 10° to 12° North. During the least hot month, January, the mean temperature is of the order of 24°C with absolute minimum 17°C and absolute maximum 30°C. During the hottest months, May and June, the average is 31.5°C, the absolute maximum of the order of 40°C and the absolute minimum rarely under 25°C.

1—*Rainfall, dry seasons and relative humidity*

The average annual rainfall in the region of Vedharanyam—Naga-

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[1] Accepted April 26, 1972.

pattinam is about 1300 mm i.e. practically of the same order as in the Marakanam-Pondicherry region.

The distribution of rainfall in the course of the year (Plate II, figs. 1 and 2) brings out well-marked maxima in October, November or December whereas the summer is dry or sub-dry according to the years. Compared to the normal tropical rainfall regime with maxima in July and August of the west coast of southern India, there is a shift of the high rains towards the end of the year. The first consequence of this regime is prolongation of the average dry season up to June. Thus the climates of the east coast of S. India manifest a long *average dry season* of at least six months duration from January to June.

Another fundamental characteristic of these climates is the large variability of rains from year to year. Even the months appearing as the most humid on basis of averages may be totally dry in certain years. The number of rainy days during the months of October and November varies from 2 to 21.

There are years with high rainfall but containing a very long dry season; this is the case of 1969 during which was recorded 1743 mm at Nagapattinam but 9 consecutive months were dry (Plate II, fig. 3). Some other years like 1970 have an attenuated and discontinuous dry season (Plate II, fig. 4).

Another essential character of the rainfall is the violence of precipitation. The usual number of rainy days per year is 55 to 70 mm but often amounts exceeding 100 mm are recorded in a day. Some recent examples are given below:

Nagapattinam — 1969 :	19 Nov.	20 Nov.	16 Dec.	27 Dec.	30 Dec.
	155 mm	100 mm	108 mm	133 mm	127 mm
Pondicherry — 1969 :	20 Oct.	23 Oct.	19 Nov.	20 Nov.	9-10 March, 1971
	165 mm	150 mm	209 mm	201 mm	242 mm

There are even more serious cases of excessively rainy cyclones precipitating more than 1000 mm in 3–4 days. This was the case in Pondicherry in May, 1943 (1097 mm).

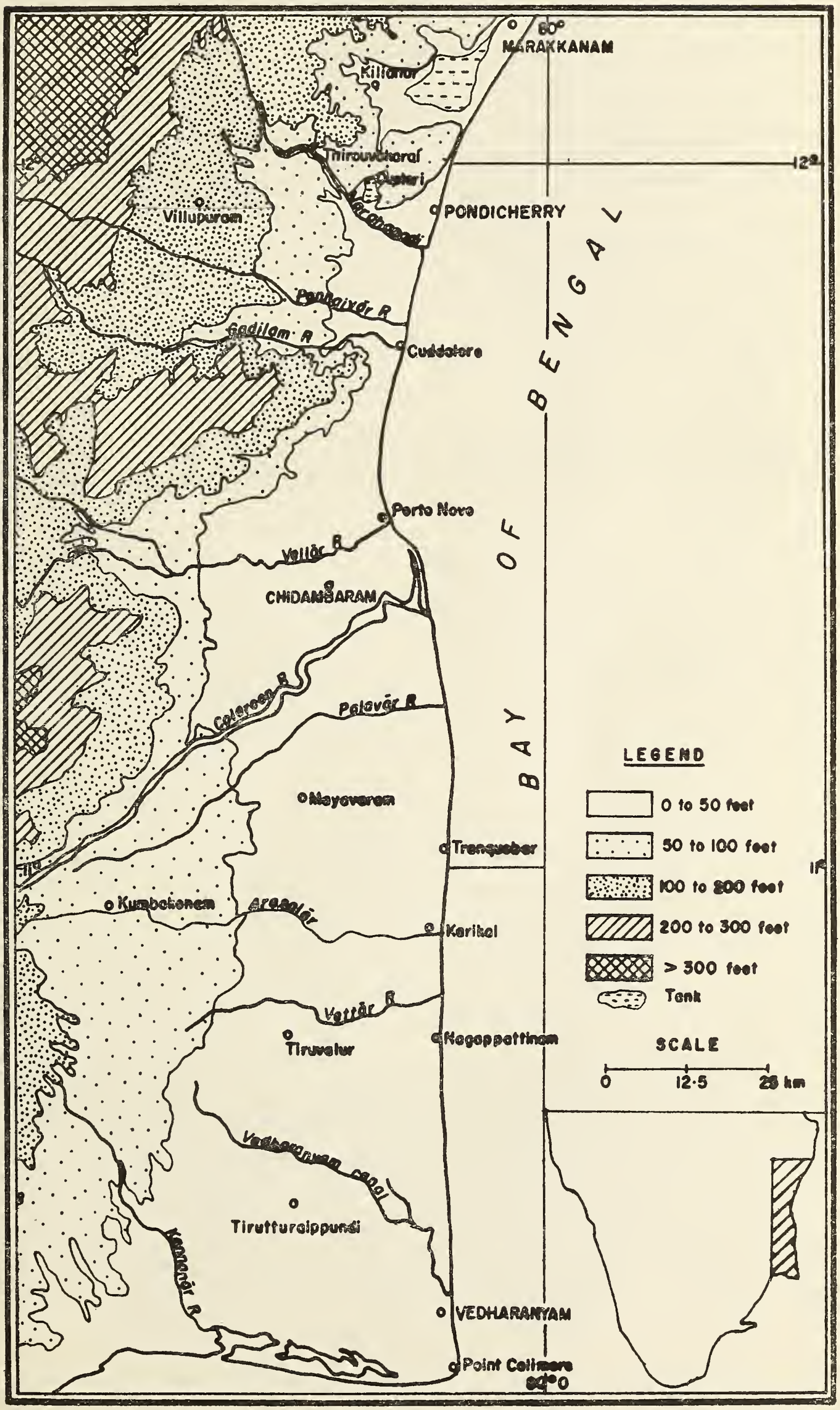
The high amount of rains are almost always of cyclonic origin. In three years (1968 to 1970) we have counted 13 cyclonic depressions and 7 cyclones that affected these coastal areas from September to December.

Detailed examination of meteorological data shows that in a normal rainfall year, on the eastern coast of S. India, 70 to 95 per cent of the rains from September to December and 40 to 70 per cent of the annual rainfall are due to the cyclones.

This uneven distribution of rain has two disadvantages: a strong erosive force of the precipitation causing considerable damage to the terrain, and a low efficiency for the vegetation. It is evident that 200

Blasco & Legris: Forest of Point Calimere and Marakanam

COROMANDEL COAST


80°
MARAKKANAM
Killanur
Thirouvakarai
Ousteri
12°
Villupuram
Varahanadi
PONDICHERRY
BAY OF BENGAL
Pennaiyar R
Gadilam R
Cuddalore
Porto Novo
Vellar R
CHIDAMBARAM
Coleroon R
Palavar R
Mayavaram
Tranquebar
11°
Kumbakonam
Arasalar
Karikal
Vettar R
Tiruvalur
Nagappattinam
Vedharanyam canal
Tirutturaippundi
Kannar R
VEDHARANYAM
Point Calimere
80° 0
LEGEND
0 to 50 feet
50 to 100 feet
100 to 200 feet
200 to 300 feet
> 300 feet
Tank
SCALE
0
12·5
25 km

OMBROTHERMIC – DIAGRAMS

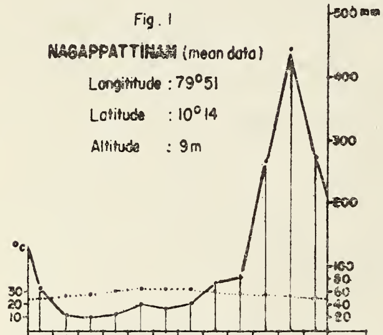


Fig. 1

NAGAPPATTINAM (mean data)

Longititude : 79°51

Latitude : 10°14

Altitude : 9m

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Rainfall	69.3	21.0	20.0	28.2	39.8	31.2	43.1	77.4	53.8	[illegible]	445	278	1406.1
N. rainy days	3.0	1.0	1.0	1.3	1.8	2.2	2.9	4.9	5.1	10.2	13.2	9.1	55.5
Mean temp.	24.9	26.0	27.8	29.7	31.5	31.4	[illegible]	[illegible]	29.3	28.0	26.2	24.9	28.4

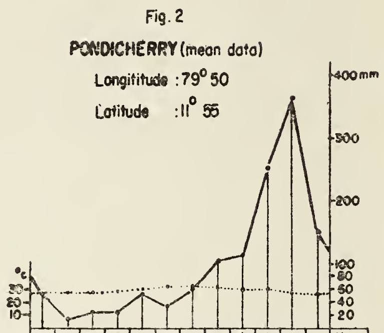


Fig. 2

PONDICHERRY (mean data)

Longititude : 79° 50

Latitude : 11° 55

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Rainfall	53	15	26	26	53	33	60	105	116	251	363	132	1256
N. rainy days	1	1	2	2	3	5	7	8	6	10	11	5	61
Mean temp	26.0	26.7	29.0	29.0	30.3	32.5	31.8	30.8	30.3	29.6	26.5	26.4	29.1

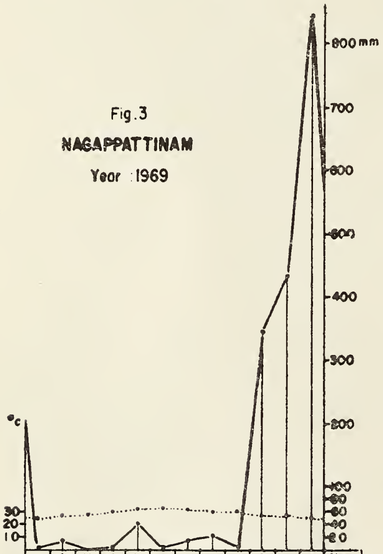


Fig. 3

NAGAPPATTINAM

Year : 1969

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Rainfall	7	14	0	9	40	2	18	20	7	349	434	843	1743
N. rainy days	2	1	0	3	4	2	4	5	3	18	13	25	80
Mean temp	25.0	26.2	28.0	30.0	32.0	32.6	31.4	30.0	30.0	27.3	26.8	25.2	184.5

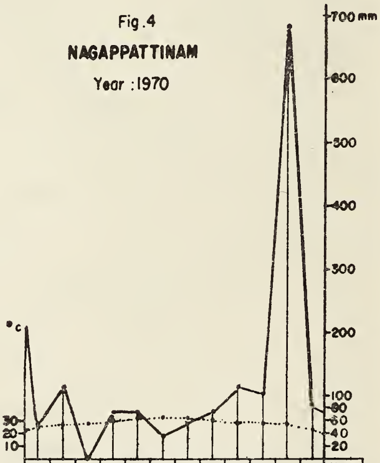


Fig. 4

NAGAPPATTINAM

Year : 1970

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Rainfall	59	113	0	73	73	39	59	73	114	104	683	87	1477
N. rainy days	4	2	0	6	7	4	7	8	4	9	15	5	71
Mean temp	25.5	26.6	29.4	29.6	31.3	31.3	30.6	29.7	29.0	28.0	26.0	24.0	340.4

mm rainfall in some hours has not the same effect on the vegetation as 200 mm in 10 days.

In these regions near the ocean, the *relative humidity* does not remain high throughout the year. The continuous records maintained at the French Institute may give some precision.

From October to March-April, its values vary between 70 and 90 per cent. On the rare rainy days the values remain practically constant between 90 and 95 per cent; on the days without rains, one observes a classical rhythm of maximum at day-break (6 to 8 a.m.) and minimum between 1 to 3 p.m.

The relative humidity is minimum in June and July when the winds are blowing over the dry land. The variations are between 50 and 70 per cent with minimum of the order of 40 per cent in the beginning of the afternoon. At this time of the year, the mean monthly deficit of saturation reaches high values of the order of 15 mm. This factor may explain certain xeromorphic structures.

Remarks

The rainfall regimes of these coastal regions of Coromandel resemble to a certain extent those of the mediterranean climate with autumn and winter rains, the summer being dry but there the comparison ends because the day-length, thermic amplitudes and the absolute minima of temperature differ completely. The tropical climates with dissymetric rainfall regime raise the problems of classification and one may question whether the distribution of the rains in the year is an important or minor factor at these latitudes where the thermic amplitude is relatively low.

The physiognomy of the vegetation types much resembles the mediterranean maquis and amongst the species which may be cultivated figure the Carob-tree (*Ceratonia siliqua*) and the olive (*Olea europaea*). The trial of acclimatization of mediterranean species covers only 4 years but we may say that their vegetative growth has so far progressed normally under the climate of Pondicherry.

2—*Physical properties of Soils*

It does not seem that there exists a very distinct edaphic unity on the littoral. At Point Calimere, the thickets develop on the dunes and alluvia; at Marakānam on a relatively light colluvium, rich in quartzite; at Ousteri and Thirouvakarai on ferruginous sandstone. Elsewhere the rock of the coastal hillocks is a type of Charnockite, hardly altered at the surface. Some precisions are given below.

"Alluvial soils and Regosols" on sand dunes of Point Calimere

Included in the Cavery delta, this coastal region is essentially formed of fluvial alluvia and dunes. The "dry evergreen" thickets grow on these types of soils.

In the coastal plains having a very slight slope, the recent deposits, essentially of fluvial origin, are called the *alluvial soils.*

The pedologic horizons are not distinct there having no clear cut separation between the horizons. The only well individualised horizon is at the surface of greyish colour in a humid state. It contains a little of organic matter. This A1 horizon is usually clayey sand, with pebbles, gravels or concretions. The average depth is 30 to 40 cm; it contains the majority of roots and rootlets. A1 may be dry in summer (May to July) but it may be covered with a thin layer of brackish water during the strong tides of September and October.

Below 40 cm, the layers are permanently humid, richer in clay but poorer in organic matter. Below the depth of 60 cm begins to appear a pale grey layer very rich in clay which is penetrated only by some big roots. Here the water-table persists even in the dry season.

As a rule these soils are halomorphic with a muddy structure in moistened state and a compact structure in dry state. The saline efflorescence is often formed at the surface due to the capillary rise of salts (mainly Sodium chloride). Their formation is favoured because of the proximity of the sea and the length of the dry season. This fact explains the presence of halophytes in the dry evergreen thickets and in the discontinuous grasslands they contain.

The "regosols" on the sand dunes at Point Calimere

Their morphology is extremely simple; the dune is composed of fine sand, yellowish white in colour. It bears a single vegetation type: evergreen thicket, more or less dense, without halophytes. A small quantity of superficial organic matter appears under the woody elements. Wherever the plant-cover is interrupted, the barren sand is exposed. These soils are consolidated only under the thicket stage; elsewhere they are continuously altered by the eolian erosion.

The "lithosols" on ferruginous colluvium of Marakanam

They have probably originated from the Cuddalore sandstone through erosion. This has caused a general loosening of the soil with apparent bed formations resulting in the accumulation of quartz pebbles alternating with layers less encumbered with coarse material. The fine material has generally disappeared at the surface, removed by the violent run-off three months per year.

The "lithosols" on colluvium or on Cuddalore sandstone have several characteristics in common:

- Their richness in quartz is such that all the farming implements are rapidly worn out.
- Only the top 20 cm of soil is of value from agricultural point of view. Below this level, the clay layers are more or less indurated. The management technique should therefore try to limit the working of the soil to the thin surface layer by scratching, superficial at the beginning, going deeper each year.
- These terrains are excessively poor in organic matter and very dry if deprived of the vegetation. A cover of trees, even scattered, is sufficient enough to change radically the properties of the upper horizon by increasing organic matter and moisture content.

Some floristic peculiarities

Thanks to the publications of Sebastine (1967) on Vedharanyam (Point Calimere) and Marlange & Meher-Homji (1965) on the Pondicherry-Marakanam region, precise botanical information is available but this is not yet complete. Here is a list of the common woody plants that we collected from Vedharanyam, not cited by Sebastine (l.c.): *Maba buxifolia, Ehretia microphylla, Ehretia aspera, Carissa spinarum, Canthium parviflorum, Pterolobium indicum, Erythroxylon monogynum, Maytenus emarginata, Atalantia monophylla, Pleurostylia opposita, Murraya exotica, Breynia rhamnoides.* A common species like *Capparis zeylanica* (Daniel 1967, p. 513) is also not mentioned.

Based on the botanical information available till present, we may draw the following main conclusions.

— This part of littoral belongs to the "eastern floristic province, Carnatic sector" (Blasco 1971), in which the number of endemics (about 50) may be considered as low.

— Over the whole of the littoral, the Dicotyledonous species would be about 500 including aquatic, mangrove and terrestrial forms.

— Over a given regional area, the maximum number of the Dicotyledons is 200 to 300. In the Point Calimere Sanctuary covering about 25 square kms of ligneous and herbaceous vegetation, one may collect about 200 species of non-parasitic Dicotyledons.

The following observations may be made from the floristic analysis of the area:

— The more or less radicant herbs form the majority, about 50 per cent of the species.

— The shrubs and undershrubs with nearly 22 per cent of species and the climbers mostly ligneous (17%) occupy second place. Arborescent vegetation contributes only about 10 per cent of species.

— An important fraction of this flora has a very vast distribution. There are about 42 (21%) pantropical species occuring in all the tropical floristic empires: *Tamarix gallica, Abrus precatorius, Tephrosia purpurea, Vernonia cinerea, Achyranthes aspera, Ageratum conyzoides* etc. There are also *zoochore* and *anthropochore* plants whose dispersal through the agency of animals and man make them ruderals or weeds of cultivated fields; examples are *Desmodium triflorum, Evolvulus alsinoides, Borreria articularis, Boerhaavia diffusa.*

— 40 species (20%) are typically Asian. A large number of species of the warmer parts of Asia is naturally to be expected in these formations: *Carissa spinarum, Erythroxylon monogynum, Atalantia monophylla, Capparis zeylanica, Gmelina asiatica, Calotropis gigantea, Premna serratifolia* etc.

— 36 species (18%) belong to India and Ceylon. Their number is inferior to the pantropical species. This Indo-Ceylon flora comprises fundamental ligneous elements like *Manilkara hexandra, Ixora arborea, Randia malabarica, Cadaba fruticosa, Maytenus emarginata, Canthium parviflorum* or very common herbs like *Mollugo disticha, Blumea obliqua, Justicia prostrata* etc.

— 28 species (14%) are Afro-Asian (some of these are Afro-Indian): *Toddalia asiatica, Cissus quadrangularis, Oldenlandia herbacea, Salvadora persica, Azima tetracantha, Pleurostylia opposita* etc.

— 14 species (7%) are common to the warm regions of Asia, Australia and Africa: *Maba buxifolia, Dichrostachys cinerea, Xeromphis spinosa, Asystasia gangetica* etc. The species common to Asia and Australia are only about 10 (5%) but some of the ligneous members are very important in these regions: *Zizyphus oenoplia, Pongamia pinnata, Pavetta indica.*

— The endemics play a minor role. According to our releves, there are only 7 of which 4 are endemic in the flora of south India (*Ceropegia candelabrum, Sarcostemma intermedium, Leucas diffusa* and *Jatropha tanjoorensis*), the remaining three are confined to Peninsular India (*Rivea hypocrateriformis, Ehretia aspera, Pterolobium indicum*). Mention may be made of *Salacia chinensis*, a Hippocrateaceae, very common in these regions but which does not seem to have been recorded in India, south of Visakhapatnam.

— This flora contains nearly 20 introduced or cultivated species which are naturalised (*Phaseolus trilobus, Mimusops elengi, Catharanthus roseus, Prosopis juliflora, Ocimum canum* etc.) and a small number of species with exceptional geographic distribution.

— A number of halophilous species occurs in the Vedharanyam region. Certain are characteristic of the saline soils, others withstand a certain amount of salinity: *Salvadora persica, Clerodendrum inerme,* *Solanum trilobatum, Excoecaria agallocha, Prosopis juliflora, Heliotropium curassavicum, Enicostemma hyssopifolium* etc.

— The above results are in general valid for the reserved forest of Marakanam too. However, the halophytes are totally absent in the thickets. A detailed examination reveals further floristic differences. The "dry evergreen thickets" of Marakanam region contain little of *Manilkara hexandra,* on the other hand *Memecylon umbellatum* and *Canthium didymum* are much better represented here. Besides, *Albizzia amara, A. lebbek, Acacia caesia, Pterospermum suberifolium, Jasminum* spp., *Gelonium lanceolatum* and especially *Chloroxylon swietenia* are found in Marakanam whereas these have not been noted in Point Calimere.

One may therefore conclude that the flora of the evergreen thickets is essentially formed of species having a vast geographic distribution and consequently a large ecological tolerance; the endemics are not only small in number but are of rare occurrence.

PRINCIPAL VEGETATION TYPES

1) *The dry evergreen thickets of Point Calimere*

At Vedharanyam the ligneous formations are found on clayey alluvium and dunes. In our opinion this is an example of the tallest and the most dense type of "dry evergreen forest" described by Champion (1936) and Champion and Seth (1968) that may be taken up for investigation.

As a matter of fact, even the best formation is stunted, almost exclusively formed of bushes much branched practically up to the soil level and measuring 2 to 4 m in height. Here and there emerge some evergreen arborescent shrubs (*Manilkara hexandra*) under 10 m in height with dark green voluminous crowns.

On the sand dunes are found the formations that we may refer to as "high, thorny, evergreen thickets". A schematic profile diagram of this formation is given (Plate III).

There is a discontinuous arborescent stratum of *Manilkara hexandra* with some *Canthium dicoccum* that is far less voluminous than *M. hexandra.*

The continuous and principal stratum is thorny with a slight numerical dominance of *Maytenus emarginata, Maba buxifolia, Randia malabarica, Zizyphus oenoplia.* Other non-thorny ligneous species are also very common but their density varies from place to place. This is the case with *Memecylon umbellatum, Murraya exotica, Sapindus emarginatus, Premna serratifolia, Ixora parviflora, Pleurostylia opposita, Canthium didymum.* Therefore, in the thicket, the majority of the species are non-thorny though the number of the individual thorny plants appears to be higher than the others. They make the entry into the thicket particularly difficult especially the invading spinescent climbing shrubs like *Toddalia asiatica* var. *gracilis.* Moreover, the number of stems per unit area is very high.

The general impression of thorny thicket is also given by the abundance of *Dichrostachys cinerea, Securinega leucopyrus, Carissa spinarum, Gmelina asiatica, Phoenix pusilla, Azima tetracantha* bushy elements at the borders of the thickets, covered with spines. They become rare or disappear in the interior of the thicket. At the borders are also found some unarmed species like *Clerodendrum inerme, Cassia auriculata, Breynia rhamnoides* and spiny climbers like *Solanum trilobatum* and *Asparagus racemosus.* Generally, the lianas grow well even in the interior of the thickets but relatively few species are encountered: *Asystasia gangetica, Cissus quadrangularis, C. vitiginea, Pergularia daemia* that do not extend up to the top of the thicket whereas *Sarcostemma intermedium* (a leafless Asclepiadaceae), *Gloriosa superba* and *Rivea hypocrateriformis* reach the highest branches.

Phanerogamic parasites are rare with the exception of *Cassytha filiformis.* The herbaceous ground cover is excessively poor.

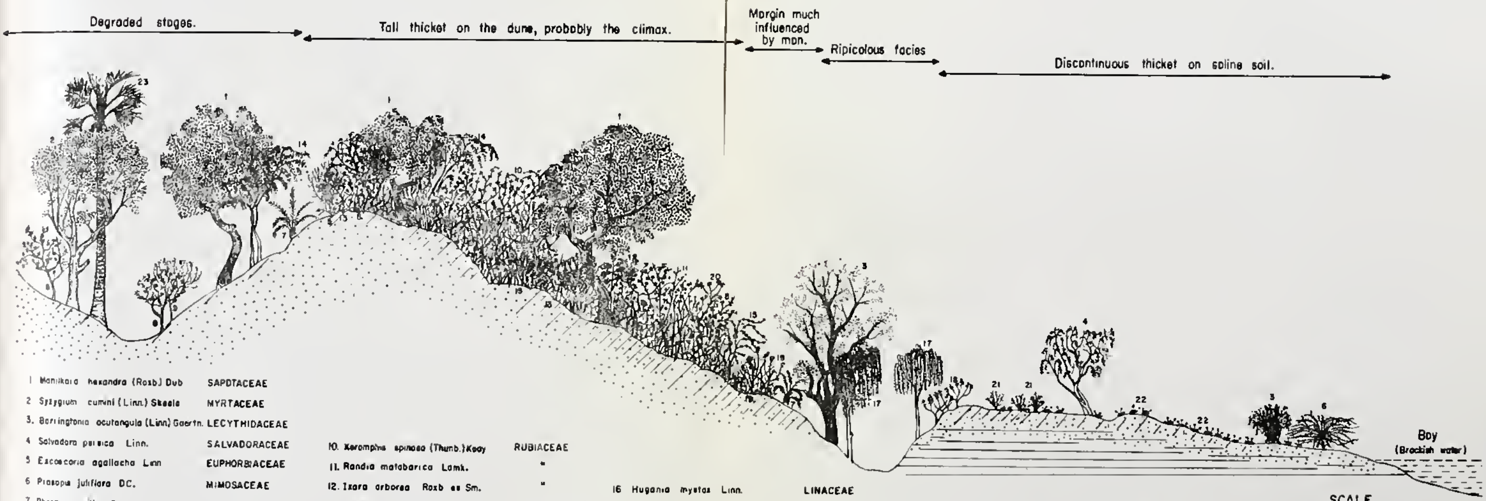
Being accessible, this vegetation is often traversed by man and openings are made in places. Also, some anthropic stages appear here and there with *anthropochore* trees like *Syzygium cumini, Borassus flabellifer, Lannea coromandelica* and others.

On alluvial halomorphic soils, "the forest is not continuous but intersected by numerous tidal inlets and creeks" (Daniel, l.c., p. 513).

There exist various stages of transitions between the purely sandy dune and the essentially clayey alluvial soils. Amongst the ligneous elements of the dunes there are many that withstand slight salinity and form thickets like those described above. Only *Manilkara hexandra,* the principal tree on the dune disappears totally or nearly on poorly drained, salty terrain. The thicket then presents a more regular appearance, less high, but the natural openings are many wherever there is saline efflorescence. Certain shrubs like *Hugonia mystax, Scutia myrtina, Salvadora persica* and *Excoecaria agallocha* are very common.

Dynamism. In absence of a detailed study, it is difficult to give precise results on the dynamism of the vegetation in these regions. One thing certain is that the thickets are often invaded by the population to get their requirement of fuel wood. On the dunes, the equilibrium of the woody species is precarious. There are hardly any seedlings of these species observed colonising the cleared areas. As their

PROFILE DIAGRAM OF THE FORMATIONS IN THE LITTORAL REGION OF POINT CALIMERE (VEDHARANYAM).


Degraded stages.
Tall thicket on the dune, probably the climax.
Margin much influenced by man.
Ripicolous facies
Discontinuous thicket on saline soil.
23
2
1
14
7
10
9
13
8
1
11
20
12
15
3
19
16
17
18
21
4
22
5
6
Bay
(Brackish water)

1	Manilkara hexandra (Roxb.) Dub	SAPOTACEAE
2	Syzygium cumini (Linn.) Skeels	MYRTACEAE
3.	Barringtonia acutangula (Linn.) Gaertn.	LECYTHIDACEAE
4	Salvadora persica Linn.	SALVADORACEAE
5	Excoecaria agallocha Linn	EUPHORBIACEAE
6	Prosopis juliflora DC.	MIMOSACEAE
7	Phoenix pusilla Gaertn.	PALMACEAE
8	Maytenus emarginata (Willd.) Ding Hou	CELASTRACEAE
9	Maba buxifolia Pers	EBENACEAE
10.	Xeromphis spinosa (Thunb.) Keay	RUBIACEAE
11.	Randia malabarica Lamk.	"
12.	Ixora arborea Roxb ex Sm.	"
13.	Memecylon umbellatum Burm	MELASTOMACEAE
14	Canthium dicoccum (Gaertn.) Merr	RUBIACEAE
15	Azima tetracantha Lamk.	SALVADORACEAE
16	Hugonia mystax Linn.	LINACEAE
17.	Cassia fistula Linn	CAESALPINIACEAE
18	Cassia auriculata Linn	"
19	Clerodendrum inerme (Linn.) Gaertn.	VERBENACEAE
20	Gloriosa superba Linn.	LILIACEAE
21.	Blumea obliqua (Linn.) Druce.	COMPOSITAE
22	Cyperus arenarius Retz	CYPERACEAE
23	Borassus flabellifer Linn.	PALMACEAE

SCALE

Height of vegetation 1cm = about 2m
Length 1cm = about 4m

5 November 1971.

growth is apparently very slow, special attention should be paid to the protection of the vegetation. It may be added that the herbaceous *Bulbostylis barbata* and *Gisekia pharnaceoides* do not appear to be very efficient in checking the eolian erosion in these regions frequently affected by the cyclones.

Practically all the thorny shrubs of the thickets may be considered as the pioneers. Under their light shade and protection, and due to the thin superficial humus layer they form, seedlings of *Manilkara, Drypetes, Pleurastylia, Canthium* etc. may develop. These shrubs, if not cut, may give rise to the discontinuous dominant stratum of the formation.

On the halomorphic soils of the tidal inlets and creeks, things are different because almost a continuous herbaceous cover precedes the woody species and also because there appear quick growing species like *Prosopis juliflora, Salvadora, Excoecaria, Clerodendrum inerme* capable of forming a bush within 5-6 years. Here is a case of vigorous dynamism, the precise stages of which yet remain to be investigated.

Between the clumps of shrubs develops a low but dense grassy carpet of Cyperaceae (about 10 cms in height) on the halomorphic soils. It is grazed by the cattle and represents a sort of equilibrium between dynamism of shrubs on the one hand and the biotic factors on the other.

This pasture is likely to be immersed under a thin layer of brackish water during the strong tides of October-November. Two Cyperaceae play an essential role—*Fimbristylis spathacea* and *Kyllinga monocephala;* in number they dominate over the other species. Another Cyperaceae—*Cyperus arenarius* may be locally very abundant. Two Graminae are not rare: *Eragrostis riparia* and *Tragus biflorus.*

The remaining flora is essentially comprised of *Phyla nodiflora**, *Portulaca oleracea, P. wightiana, Leucas diffusa, L. aspera, Oldenlandia umbellata, Evolvulus alsinoides**, *Hybanthus enneaspermum, Tribulus terrestris**, *Boerhaavia diffusa**, *Phyllanthus niruri, Borreria articularis.*

In these pastures, isolated shrubby elements are not rare. These are almost always *Prosopis juliflora* and some species of the back mangroves like *Excoecaria agallocha, Clerodendrum inerme, Suaeda maritima* and *Salvadora persica.*

2) *The dry evergreen thickets of Marakanam—Physiognomy and flora*

The colluvial terrain includes an important proportion of clay between gravel. Therefore these soils are apparently more favourable to the shrubs than the dunes of Vedharanyam as they have larger moisture retentive capacity. However, the abusive and selective exploitation of unarmed shrubs for the production of green manure has totally altered the physiognomy and floristic composition of the formation. But away from the roads there remain some vestiges that are only slightly disturbed and that may be considered as quite representative and probably near the climax.

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* These are pantropical species.

At first view the formation resembles a mediterranean maquis. However, it contains an extraordinary quantity of large shrubs, the girth of stems being 1 to 30 cm, and lianas. Over one square metre one may count up to 10 ligneous species, confusedly intermingled. Therefore, in our opinion, it is not possible to give a correct account of the structure of the formation with a photograph as there is too much of overlapping and lack of clarity.

The overall aspect is that of a dense and continuous thicket of an average height of 2-3 m, from which emerge isolated or in clumps some small trees with thick foliage. The principal cover bristles with thin terminal branches, mostly spiny, hanging like an arch above the thicket.

At the margin, many shrubs belong to complex life-forms, commonly referred to in the English literature as *scrambling, straggling or climbing shrubs;* it is sometimes difficult to distinguish between these forms. The more common species make the formation impenetrable; amongst these may be cited *Gmelina asiatica, Carissa spinarum, Capparis stylosa, Hugonia mystax, Pterolobium indicum, Fluggea leucopyrus, Cansjera rheedii, Acacia caesia, Calycopteris floribunda, Strychnos colubrina.* These microphyllous, spinescent, light demanders form a spiny, dense rampart around the thicket. They may penetrate deeply in the formation because of the clearings made in the thicket. In the openings are found pioneer species, the most remarkable being *Dodonaea viscosa, Cassia auriculata, Dichrostachys cinerea,* and some rare succulent species: *Euphorbia antiquorum, Caralluma* spp., *Sanseveria roxburghiana* etc.

In less disturbed thicket, the flora changes. Amongst the more common species may be cited *Maba buxifolia, Erythroxylon monogynum, Ehretia microphylla, E. aspera, Xeromphis spinosa, Atalantia monophylla, Premna serratifolia, Drypetes sepiaria* but special mention must be made of *Memecylon umbellatum, Canthium didymum, Ixora parviflora* and *Murraya exotica.* The last mentioned three species sometimes emerge 2 to 3 m above the thicket but sometimes are at the level of the thicket or below it, flowering and fruiting at the stage of dwarf under-shrubs, 50 cm high. These variations in life-forms of a same adult species, in a same formation, baffle phytogeographers and botanists. Two other factors also add to the confusion; these are the extraordinary density of the branches and the convergence of the growth-forms. Most of the species are spiny microphyllous or squamophyllous with thick and dark cuticle.

This continuous stratum of under-shrubs (2 to 3 m) contains a large number of climbers belonging mainly to the genus *Jasminum* (*J. sessiliflorum, J. angustifolium, J. auriculatum*), others are spiny like *Asparagus racemosus* and *Zizyphus xylopyrus,* certain are succulent and nearly aphyllous like *Cissus quadrangularis* or totally aphyllous with chlorophyllian stem: *Sarcostemma acidum.* The last mentioned reaches the dominant shrubby stratum (6 to 10 m high), like *Ipomoea sepiaria, Ventilago calyculata,* and *Pachygone ovata.* The dominant stratum is discontinuous, poor in species and the small trees and shrubs composing it are morphologically very distinct. The most characteristic (but much scattered and even rare at places) is undoubtedly *Manilkara hexandra* with its stocky bearing, low branching, clothed with a thick bark that is deeply vertically striated. *Chloroxylon swietenia* on the other hand has compound leaves with thin light green leaflets and light and smooth bark. This Meliaceae of India and Ceylon that is still in demand for its wood is found much scattered in these thickets. It is a heliophilous species and hence cicatricial and non constitutive.

Then, in the decreasing order of abundance comes *Memecylon umbellatum,* a hardy Melastomataceae, known through different varieties in most countries of tropical Asia. It is clearly distinguished from *Canthium didymum,* another species with simple, opposite but larger leaves with stipules and bearing flowers in the axil of the petioles. Another common shrub that may be easily identified in the field is *Pterospermum suberifolium;* it is mesophyllous with the lower surface of the lamina covered with a white tomentum.

These five species are invariably the most to be seen with some *Albizzia lebbek, Dalbergia paniculata* and *Albizzia amara.*

The parasites are not rare. *Cassytha filiformis,* a pantropical Lauraceae, is seen on several host species; *Dendrophthoe falcata* grows on *Ehretia monophylla* and *Viscum orientale* on *Manilkara.*

The herbs cover a small portion of the ground in discontinuous patches. A Graminae, *Aristida hystrix,* is quite common and Acanthaceae are well represented by *Lepidagathis cristata* (apparently endemic to India), *Blepharis maderaspatana* (a radicant plant, in our view indicator of biotic interference, known almost throughout Asia and parts of Australia), *Barleria prionitis, Stenosiphonium russelianum* var. *subsericeum* and *Andrographis paniculata* (all the three being rare).

Bulbous plants are very rare.

PHENOLOGY OF THE PRINCIPAL SPECIES

Almost all the bushy species are evergreen, although some may be partially defoliated for some days per year. The arborescent species are evergreen (*Manilkara, Pterospermum*) or deciduous for a very short time (*Maba buxifolia*) or yet distinctly deciduous (*Albizzia, Dalbergia, Vitex, Gyrocarpus, Chloroxylon*). Anyway, the number of individuals of deciduous species is quite low compared to that of the evergreens.

From the point of view of flowering, rarely we have come across such complex formations in south India. In spite of the long dry season, the period of vegetative growth and flowering is spread over the entire year. Everything seems to depend on the species. Some like *Cadaba indica, Ixora parviflora, Tarrena asiatica, Gmelina asiatica, Asystasia gangetica, Cassia auriculata* flower throughout the year. However, every species seems to have its own phenological rhythm. Here there are two peak seasons of flowering, one during the dry season (January to May), the other during the rainy season. Certain species have even two periods of flowering. *Manilkara hexandra* flowers abundantly in November; the fruits mature till February; this is followed by some flowering in March and April. We have also noted that *Murraya exotica* flowers several times a year: end of November, end of February—beginning of March and sometimes also in July.

Those flowering essentially during the dry season are *Cansjera rheedii, Hibiscus micranthus, Sapindus emarginatus, Croton* sp., *Ventilago maderaspatana, Pachygone ovata, Fluggea leucopyrus, Drypetes sepiaria, Maba buxifolia, Scutia myrtina, Carissa spinarum, Flacourtia indica, Capparis brevispina, Gyrocarpus jacquinii, Calycopteris floribunda* and the above mentioned Acanthaceae.

Species flowering essentially during the rainy season (August to November-December) are *Jasminum angustifolium, J. auriculatum, Sarcostemma brevistigma, Strychnos colubrina, Premna serratifolia, Ehretia aspera, E. microphylla, Hippocratea obtusifolia, Pterolobium indicum, Gmelina asiatica, Dichrostachys cinerea, Manilkara hexandra, Zizyphus* spp., etc.

Therefore, the determinism of flowering in these regions is complex, so to say unknown. Besides, the flowering periods are not constant from year to year. For the same species, the period is variable from one individual to another in the same year and in the same habitat. No doubt this population contains many individuals possessing absolutely fixed characters but others fluctuating according to the habitat, the latter conferring on the population a large ecological plasticity thus explaining their vast distribution.

The dynamism

Totally bare soil is limited in extent over the lateritic caps. The reconstitution of vegetation on such a site seems excessively slow. Here we observed:

— a characteristic Graminae *Chrysopogon fulvus* with short leaves gathered in narrow rosettes.

— *Justicia prostrata,* a very small Acanthaceae of about 5 to 8 cm and *Evolvulus alsinoides* with branches lying flat on the soil, spreading horizontally.

— *Heteropogon contortus,* rare because of browsing, *Stylosanthes mucronata,* non-spiny suffrutescent, also browsed and *Xeromphis spinosa* are observed at some places. The last mentioned thorny Rubiaceae known throughout the old tropical world plays the role of a pioneer species over the sandstone *lithosols* in south India. *Cassytha filiformis* spreads its long, slender, leafless branches on the soil.

— *Generally the barren lands are the fallows.* In course of some months they get covered with an almost continuous vegetation.

— *The coarse sand,* partially cleared of pebbles and quartz gravel, is colonised by small plants: *Rhynchosia aurea,* a Papilionaceae, occupies most of the area with *Mollugo pentaphylla, Crotalaria medicaginea* var. *herniarioides, Euphorbia corrigioloides, Bulbostylis barbata* and *Merremia tridendata.* However, the most abundant species is *Leucas lavandulifolius.*

— *The fine sand* from which the gravel is artificially removed, evidently contains the preceding species but the vegetation is more dense and the dominant species is *Borreria hispida.* In addition are found *Cyperus compressus* (quite abundant), *Sida rhombifolia, Commelina attenuata, Rothia trifoliata, Zornia diphylla, Z. gibbosa* and others.

Four Graminae are commonly present: *Chrysopogon fulvus, Heteropogon contortus, Cymbopogon flexuosus* and *Aristida setacea.* The last mentioned dominates largely as the soil becomes rich in clay. However, these grasses that form important grasslands elsewhere in south India (Blasco 1971), play only a secondary role here so that the grassland fires are unknown in these regions. This may explain the rapid rate of progression of the shrubs that almost always begins by the vigorous implantation of the thorny species: *Xeromphis spinosa, Scutia myrtina, Flacourtia sepiaria, Carissa spinarum* and *Phoenix pusilla,* a dwarf palm with a short stem or stemless. In the first stages, these species tend to eliminate the herbaceous plants, spread their branches at the soil level and thus occupy a large area in spite of the small number of individuals. Later on, by their own seeds and that of the other species arriving afterwards, some spiny (*Dichrostachys, Pterolobium, Cadaba*), some toxic or left untouched by animals (*Dodonaea viscosa, Cassia auriculata, Vitex*), they multiply considerably the number of stems making the young formation inextricable. Thus a seedling or a young plant of these pioneering shrubs has every chance of producing an adult if man has no need of firewood. A return to a stage close to the climax,—tall, dense thicket,—seems possible even from the much degraded pseudo-steppic type. Furthermore, it does not appear that a period as long as a century is required by this young formation to reach the climax physiognomy, because the vigour of these species under the climate with a long dry season is indeed surprising. Certain experimental plots of *Eucalyptus* plantations raised in 1963 and subsequently abandoned are presently covered with an impenetrable thicket, more than 2 m high. It is so because the flora of the region essentially contains species endowed with a remarkable colonising capacity.

THE CONVERGENCE OF FORMS

The preliminary contacts with these formations leave the same general impression on everybody: the remarkable convergence of forms, to such an extent that without an attentive examination of each species, it is difficult, even for a botanist, to distinguish species belonging to totally different families. Most are bushy, sclerophyllous, with thin, twisted stems, branching near the soil and intermingling. The leaves of *Ehretia microphylla, Xeromphis spinosa* and *Maba buxifolia,* for example, do not measure more than 1 cm by 0.5 to 0.8 cm. Those of *Flacourtia indica, Fluggea leucopyrus, Gmelina asiatica* and various jasmines are not much different.

A careful study soon reveals that in these thickets are encountered practically all the terrestrial forms of low altitude ranging from evergreen shrubs to tropophytes, from thorny or unarmed bushes with chlorophyllian stem (*Capparis brevispina, Cansjera rheedii*) or not to succulents (*Caralluma, Euphorbia*) to leafless climber (*Sarcostemma*). The complex mixture comprises microphyllous, evergreen bushes, spiny or not, mesophyllous unarmed shrubs with simple, evergreen leaves (*Manilkara, Pterospermum*) (leaves measuring at least 10 cm × 5 cm); others are non-spiny with compound leaves, mostly deciduous, (*Chloroxylon, Albizzia, Dalbergia, Sapindus*). A peculiar aspect is that non-deciduous shrubs with large, elongated lamina have a dense and thick foliage whereas certain microphyllous species are less leafy.

What is the exact significance of the physiognomic convergence in the formations separated from each other by long distances? The evergreen thickets of south India, the "sclerophyllous-xerophytic edaphic" *maquis* of New Caledonia (Virot 1956, p. 172), the evergreen sclerophyllous formations described for Chili (Mooney 1971) etc.

constitute phytocoenoses comparable in their physiognomy but appear to be quite distinct in ecology and flora.

As regards the anatomical structure of the leaves, one often observes, though not always, a thick cuticle, a waxy coating, much development of the palisade tissue, reduction in spongy parenchymatous tissue, increase in the number of stomata and pilosity. These characters are generally taken as adaptations to a dry habitat. However, on a purely physiological basis Maximov (1929) has demonstrated that such anatomy facilitates gaseous exchange and sometimes also transpiration. In very humid sites of the evergreen forests, the leaves also possess a thick cuticle and waxy coating although there is no necessity to economise water.

It may also be noted that the exact role of trichome remains to be defined for if the lower surface of the lamina is very hairy in some species (*Pterospermum suberifolium*), the leaves of most of the species are glabrous. Finally, the reduction in the size of the leaves does not necessarily correspond to a reduction in the evaporating surface if the large number of leaves compensates for the small size.

These apparently contradictory explanations resulting from a superficial examination should be supplemented by physiological studies in connection with the habitat of which we have given fundamental characteristics.

CONCLUSION

The climate of the littoral is often classified, not in a very precise manner, in "dry sub-humid" (Koelmyer 1957, Subrahmanyam & Sastry 1971) complex climatic types in which the averages have no real value because according to the year the climate may be considered as humid or very dry.

The adaptational forms of the species to these fluctuations are very diverse. Anatomical and physiological studies are required to determine whether the shrubs of the formation are effectively adapted to economise moisture.

In our view, there do not exist any "dry evergreen forests" (Champion & Seth 1968) in south India but only thickets, more or less dense and tall. They are at least of two types, quite distinct in their flora, phenology, soil type on which they develop– one evergreen on halomorphic soils and on dunes (Point Calimere), the other on ferruginous *lithosols* include a number of deciduous shrubs (Marakanam).

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The Langurs of the Gir Sanctuary (Gujarat)— A preliminary Survey[1]

BY

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(*With three plates and two text figures*)

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The findings presented here relate to observations made on the social life and allied aspects of langur (*Presbytis entellus*) behaviour at Gir Forest. The investigations were carried out for a period of one month during July/August, 1971. In all 24 troupes were actually encountered though a few more were reported to be present over an area of about 6 square km along the trekkable roads. The majority of these troupes were located in the western Gir where the vegetation was typically riverine with deciduous trees, while only a small number were seen and were reported to exist in the eastern part with its scanty food supply and poor cover. Though a variety of trees exist in eastern part they do not provide enough food for the choosy langurs. Some of the troupes lived near cultivated fields which they sometimes invaded in quest of food.

Out of the 24 troupes encountered, the composition and size of eleven troupes was studied. Of these 9 were bisexual, one an exclusive male troupe, and one a 'male-bisexual' troupe. The average troupe size was 30.44 for the bisexual troupe and 2.0 for the exclusive male troupe. The average male-female ratio in a bisexual troupe was 1:5.28. The linear extent of the home range was between 2½ to 4 km and the troupe size appeared to influence the extent of area covered.

DESCRIPTION OF THE STUDY AREA

The Gir Wild Life Sanctuary is a managed teak and acacia forest. Located in Junagadh district of Gujarat State, about 320 km north-

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west of Bombay and 280 km southwest of Ahmedabad, it is approximately 64 km long by 24 km wide and encompasses about 1255 square km with elevations ranging between 226 m and 648 m above sea level.

The region has three seasons: cool dry from early October to February with minimum temperature reaching 7.2°C; hot dry between February and June with maximum temperatures of 43.3°C; and monsoon from late June to early October with irregular precipitations accounting for most of the annual rainfall of 300-450 mm. Several types of recognisable plant associations have been identified: *open teak forest on red soil,* about 10 m high and the canopy consisting of 70-90 per cent of aged teak. The understory consists of *Carissa carandas* and other dense shrubs along with deciduous shrubs like *Helicteres isora* and thorny species of *Acacia* and *Zizyphus.* Grasses include *Themeda quadrivalvis* and *Sehima nervosum. Dense teak forests,* found on gentle slopes with black soil, are close and spread over 60 per cent and are about 15 m high. Other trees are non-thorny and deciduous. A dominant grass is the tall, shade tolerant *Apluda mutica. Dense thorn forest* 4-8 m high with an overstory of 70 per cent of *Acacia arabica* occurs commonly on flats or gentle slopes and around nesses. This formation is typically found on rich and black soil with relatively poor drainage. A *dry tropical riverine vegetation* is restricted to both the perennial and intermittent drainages. It is dominated by evergreen species like *Syzygium rubicundum* and *Pongamia glabra* which rises to 25 m; the dense understory consists of evergreen shrubs such as *Carissa carandas* and the ground is covered with shade tolerant grasses like *Oplesmenus burmanii.*

About 8000 maldharis[1] occupy 129 nesses[2] within the sanctuary. Several "forest settlements" or pockets of agriculture, occur within the sanctuary. The forest is an important watershed for much of the surrounding agricultural land. Four miles north of Sasan, Kamleshwar dam impounds the largest man-made lake in Junagadh district.

Equipment and Method of Study

Observations required only a camera, binoculars, compass, field notebook and occasionally a hand drawn map of Sasan Gir locale.

For nearly a month regular trips were made into the forest, especially into those areas that had running streams with riverine vegetation, and the negotiable roads were investigated for the presence of

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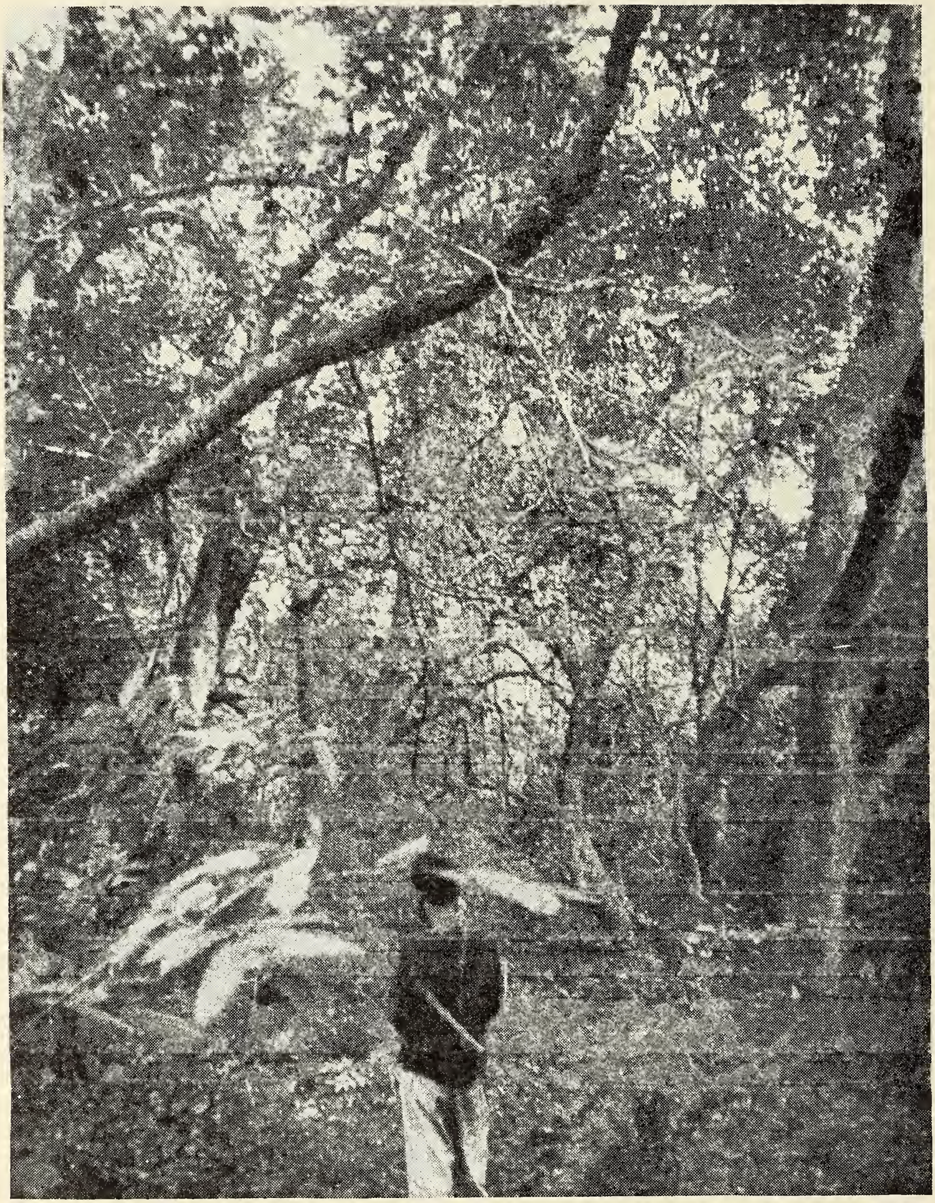
[1] Graziers. [2] Villages.

Typical riverine habitat

(*Photo : Author*)



Overhead canopy formed of entangled branches across a stream

(*Photo : Author*)

monkeys. As the study period was short, the discrimination and identification of a few members from different troupes was not possible. Thus for the study of the population the main interest was focussed upon the size and composition of different troupes, as either or both varied for different troupes. As the vegetation was too dense to permit an easy count of all individuals, the counts were taken as the animals crossed open terrain such as roads or patches of grass or nullahs. Sometimes they were manoeuvered by me into crossing areas where they could be properly counted.

The troupes located near Sasan village were then selected for studies on home range, roosting places, day range, interspecies and intraspecies interactions etc. These two troupes were constantly followed, sometimes with the help of a local guide, from sunrise until the langurs settled down for the night which was sometimes as late as 1930 hrs. The troupes were followed on foot along the dry nullah bed or across the river for about a week.

Observations were recorded briefly and later transcribed and expanded. The movement, feeding, and roosting places were plotted on a hand drawn map. The daily notes included such details as feeding, roosting, social interactions, procession pattern, number of progressions, preferred areas and extent of area covered etc.

The observations recorded were not totally free from bias as they were greatly hindered by the limitation of time and observations during the monsoon at Gir. The time spent in contact with monkeys was short and the animals were visible only for a few hours a day. The animals were difficult to find and were likely to be lost on crossing a river or moving away. They did not become habituated to the author's presence during the short period. It thus took much time to gather a reasonable body of data.

The quality of data gathered was also affected by poor visibility, as many monkeys were screened behind leaves and their activities could not be determined. The observations were sometimes fragmentary as the animals could not be observed from close range as a silent approach was impossible in the thick growth. In any behavioural interaction all the participants were rarely visible and thus the amount of data collected during the month of study was not sufficient for correct interpretation. A long term study covering other seasons would avoid these drawbacks.

RESULTS

Population

During the study period 24 troupes were seen. Although more monkeys were reported to be present, only those that were actually seen have been marked on the map (fig. 1). Of these 24 troupes, 22 were located in the western and the other 2 in eastern Gir. Apparently the majority lived in western Gir owing to the preferred habitat (riverine) and abundance of food. The scrubby vegetation with acacia and zizyphus of the eastern Gir did not harbour many monkeys. Though, not much time was spent in the quest of monkeys in east, I was advised by the local inhabitants that they were rare. The few rivulets of the eastern Gir and the trees such as *Wrightia, Terminalia* and *Syzygium* associated with them harboured the few langurs that were encountered.

Of the 24 troupes, the size and composition of 11 were analyzed (Table 1). Twenty troupes were bisexual; one exclusively male, and one 'male-bisexual'. Among the bisexual troupes the largest one had 48 individuals (Sasan-fence troupe) while the smallest (Jamwadla and Hiran troupes) had 16. The largest proportion of males to females within a bisexual troupe was 8 males: 11 females in the Chitrode troupe and the smallest was 1 male: 22 females in the Amrutvel troupe. The average bisexual troupe size was 30.44 while the average was 15.1 for Hanuman langur at Dharwar (Sugiyama *et al.* 1965). The average ratio was 1 male: 5.5 females in bisexual troupes. The exclusive male troupe consisted of 3 males and was located about 4 km from Sasan village. The adult member of this troupe was seen attempting to join the Chitrode troupe.

The single male (Sasan station troupe) which for unknown reasons led an isolated existence, visited human dwellings and ate proferred food. This male joined the Sasan fence troupe at will without being resented by others and it is possible that he belonged to that troupe originally but became isolated from them by visits to human habitation. Nevertheless he was sometimes away from the troupe and completely cut off from it for as long as a couple of days leading a solitary life and hence treated as a separate male-bisexual troupe. No solitary langur was seen in the Dharwar area (Parthasarathy, personal communication).

Home range and roosting places

The daily movement of two selected troupes (Sasan fence and Sasan hiran) was studied over a ten day period to determine the extent of home range, number of roosting places and the core areas etc. The Sasan fence troupe had its home range running along the nullah and stretching roughly between Chodia road to the north and Visavdar road to the south. The area covered was roughly 4 km (fig. 2).

The Sasan hiran troupe made excursions over an area of about 2½ km along the Hiran river bank, more often along its northern bank.

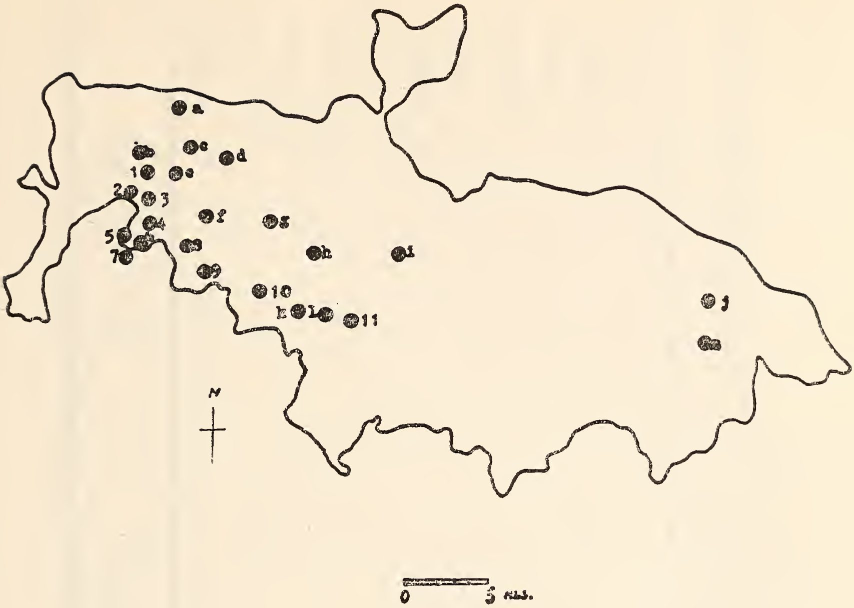

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Fig. 1. Location of the 24 troupes at Gir.

1 to 11 are the troupes whose size had composition was studied. a to m are the ones whose size and composition could not be studied.

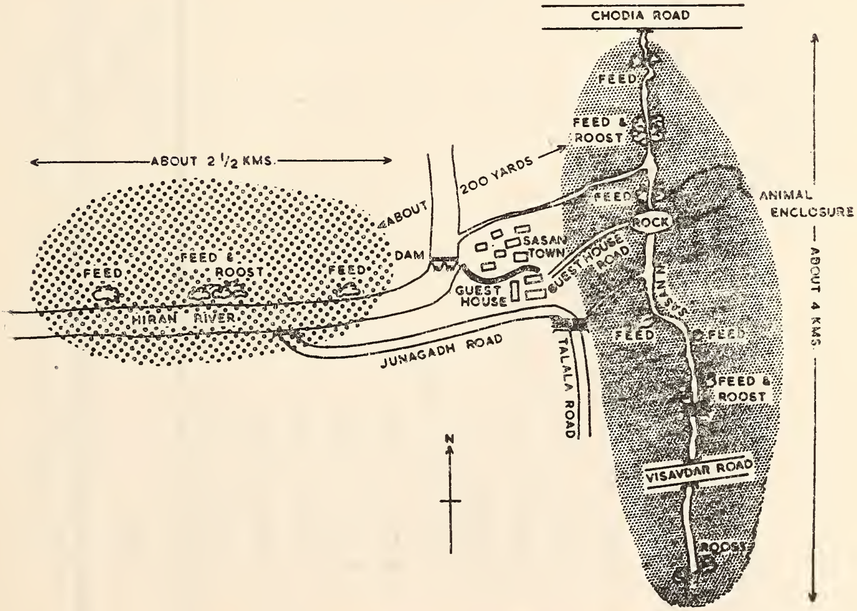

CHODIA ROAD
FEED
FEED & ROOST
ABOUT 2 1/2 KMS.
200 YARDS
ABOUT
ANIMAL ENCLOSURE
FEED
ROCK
SASAN TOWN
DAM
FEED
FEED & ROOST
FEED
GUEST HOUSE
GUEST HOUSE ROAD
HIRAN RIVER
JUNAGADH ROAD
TALALA ROAD
FEED
FEED
FEED & ROOST
VISAVDAR ROAD
ROOST
ABOUT 4 KMS.
N

Fig. 2. Home range of the troupes.

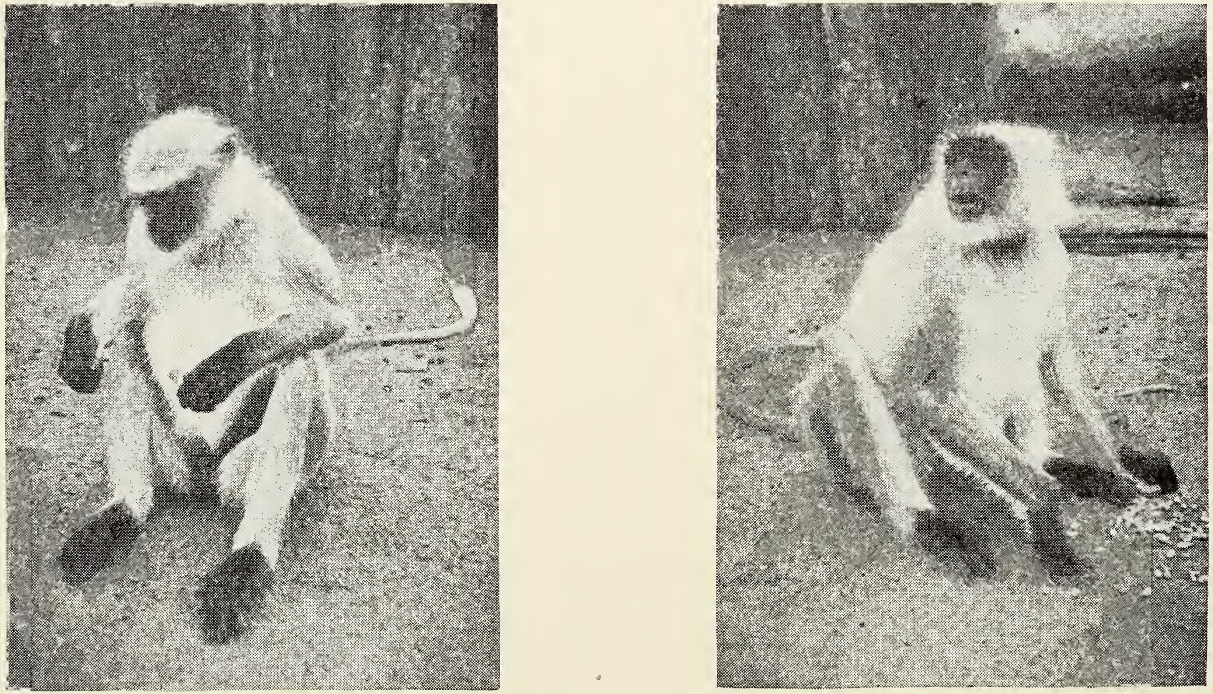
Sasan-fence troupe is represented by small dots and Hiran troupe by larger ones.

TABLE 1

COMPOSITION OF THE TROUPES STUDIED AT GIR

Sl. No.	Name of the troupe	Adult males	Subadult males	Adult females	Subadult females	Juveniles	Babies	Total	Comments
1	Pilipat Troupe	2	2	27	3	1	3	38	Bisexual
2	Sasan Gir fence troupe	3	1	10	19	9	6	48	Bisexual
3	Sasan Gir Hiran troupe	1	—	8	3	2	2	16	Bisexual
4	Sasan Gir Station troupe	1	—	—	—	—	—	1	Male|Bisexual
5	Chitrode troupe	6	1+1*	9	2	1	3	23	Bisexual
6	Talala Road troupe	1	1	10	—	2	4	18	Bisexual
7	Karanya troupe	1	2	—	—	—	—	3	Male troupe
8	Kapuria troupe	2	4	15	6	9	5	41	Bisexual
9	Amrutvel troupe	1	?	20	2	3	4	30	Bisexual
10	Shirvan troupe	3	1	23	8	2	6	43	Bisexual
11	Jamwadla troupe	1	—	3	1	8	3	16	Bisexual
	Total	22	13	125	44	37	36	277	
		35		169		37	36	277	

1 * One subadult male killed and eaten by dogs.



Left : The solitary male (station) individual visiting human dwellings. *Right :* The solitary male grinds his teeth on the approach of a dog

(*Photos : Author*)

The langurs that lived on riverine vegetation spent only 10 per cent of their time on the ground while the ones in more open habitat (Talala road) spent as much as 30-40 per cent time on the ground. The former fed on tree tops while the latter spent much of their time on the ground searching for worms and pupae that formed a major part of their diet.

It was difficult to make out specific core areas unlike the langur at Dharwar (Sugiyama *et al.* 1965) as they had the habit of spreading out over a wide area. The feeding areas however, appeared to serve the function of core areas as well, where the langurs spent a considerable amount of time. This observation is further strengthened by the fact that though suitable feeding trees are present all along the length of the home range, only a few selected ones are usually visited by the langurs.

Morning activities (0600 to 0700 hrs) on a bright sunny day and in the evening between 1700 to 1800 hrs were quick. They left the roost in the morning for feeding and usually covered the whole extent of the home range. There was no clear pattern of troupe movement. The subadult females in many cases led the procession and, rarely, the dominant male who usually whooped before leaving the sleeping quarters.

The home ranges of the two troupes studied did not overlap at any point and there was an actual gap of about 200 yards between them made by Hiran river. It was therefore not possible to study interaction between these troupes. However langur at Gir did move within clearly demarcated boundaries. This was illustrated by the behaviour of the Sasan station solitary male who sometimes joined the Sasan fence troupe. This male had the habit of threatening and chasing moving jeeps. He had a specific area within which he was found and he chased vehicles only up to a certain point and then returned. He was never seen chasing any vehicle beyond that point as if he was satisfied with seeing the vehicle off his range.

The Talala road troupe that was studied for 5 days again appeared to keep clear of the boundary of Chitrode and Karanya troupes. It seemed probable that the overlapping of home ranges studied elsewhere for other primates was mainly due to pressure on available space.

However the Karanya troupe sometimes did invade the home range of Chitrode troupe but this did not indicate an overlap in true sense as the former was an all-male troupe and had no fixed range. All-male troupes have been noted not to observe strict territoriality (Sugiyama *et al.* 1965).

As the extent of range was not studied during different seasons of the year, especially summer, it was difficult to record whether the range remained unaltered throughout. Starin (personal communication) stated that there was no marked difference in the extent of area covered by Jamwadla troupes between summer and monsoon. Bonnet macaques are known to move over long distances, sometimes even beyond the confines of home range, if food is insufficient and more so during summer. If the contrary was true for the Gir langurs it would suggest:

(a) that food was uniformly available during different seasons, either in the form of leaves, fruits or flowers as the vegetation along a stream or river was not dependant upon rains.

(b) that the langurs continued to roam about over the whole extent of the home range even during the monsoon irrespective of the availability of food.

The troupe between Asundrali and Odi Ness in the eastern part, confined its movements to a small area along the Kogham stream. It roamed over an area of about 2½ to 3 km, but stopped about ½ km short of Odi Ness, though the vegetation was similar and extended as far as Odi Ness itself. This indicates that the langurs did not exploit a larger area than necessary and that the area between its home range and Odi Ness was too small for another troupe to occupy. It is probable that the langurs, atleast those in eastern Gir, extend their range in summer as the food becomes scanty when the nullahs dry up.

The dominant male and sometimes adult females watched from tree tops. If vision was obstructed by branches, they were parted and held apart. While on the ground, two langurs often sat back to back, as if to watch in opposite directions. The topmost branches were normally occupied by vigilant males and mothers with infants, the middle part of the canopy by adult females and subadult males and the lower part by juveniles. The vigilant individuals warned others of any approaching danger by giving out a whoop or alarm bark. Two males of Karanya troupe invariably watched while the third fed in cultivated fields.

The whoop sounded very much like the call of the crow pheasant (*Centropus sinensis*) and was given out by the adult male in various contexts. The earliest whoop was heard at 0600 hrs and the last at about 1920 hrs before retiring. The animal may call once or more. The maximum number heard was 9 whoops within 3 minutes. The Chitrode troupe whooped on spotting the Karanya troupe. The whoop may accompany the bark of alarm on detecting danger such as a panther. Whoops were given out from tree tops but never from the ground. In many cases a deep whoop resulted in an involuntary agitation of the branch which could be related to branch shaking noticed among other primates. The whoop accompanying the bark of alarm indicated panic and sounded like *ahoon, ahoon, eh, eh; ahoon, ahoon, eh; ahoon,*

ahoon, eh, eh, and so on and the animals in this state urinated and defecated. *Ghrr, Ghrr....* by the dominant male announced the passing of danger. A whoop with or without the accompaniment of teeth grinding announced dislike and threat and was directed at less dominant individuals or the observer. The teeth grinding sounded very much like the croaking and was emitted by opening the jaws with a snap and then closing slowly and was sometimes directed at dogs also. The juveniles gave out a squeal which might mean dislike or fear as directed at the observer, but they were silent on seeing a panther. The squeal was very similar to that given out by a bonnet baby that was left alone. A soft squeal given out by juveniles to the more dominant individuals indicated their desire to groom.

Langurs did not have a single roosting place, but a number of selected tall trees served the purpose. Sometimes they slept on the feeding trees. The Sasan-fence troupe slept mainly on a ficus tree to the north of the Railway bridge and sometimes on a *Terminalia* clump to the south of Chodia road. On two occasions the troupe was seen roosting on tall teak trees to the south of Visavdar road.

While the Hiran river troupe was seen roosting on Tamarind and *Syzygium* trees, the Talala road troupe slept consistently on a ficus tree, the only large tree located in that area of low teak and cultivated fields. The Kapuria troupe was seen roosting on a very tall *Holoptelea* tree next to the Forest quarters on two consecutive nights.

It was not uncommon for the troupe to spread over four to five trees and sleep. The Talala road troupe on one occasion split up into two parties and slept in two different places. One party of two females with infants and two juveniles led by a subadult male slept on the usual ficus tree, while the rest (Table 1, for composition) led by the dominant male slept on a *Soymida* tree about 1½ km from the ficus, but well within the home range. The next morning the parties reunited.

The troupes living in thick forest areas with riverine vegetation settled down for the night's rest around 1800 hrs while the ones in the more open areas continued to spend time on the ground sometimes until as late as 1915 hrs. Before retiring the dominant male would whoop or yawn. There was no definite pattern in the act of climbing a tree by members of different status or sex. After having settled down, some individuals displayed a vocalisation like teeth grinding but lower in pitch, whose significance could not be determined as it was given out in darkness; possibly it served to establish relative positions.

Thick horizontal branches were selected to lie down. The animals, either individually or in groups of two or more, huddled together or lay with their limbs and tails dangling. Sometimes a fork with one horizontal and another vertical branch was selected and the animal sat on the horizontal branch and embraced the vertical one; sometimes the head was also placed on the latter. To prevent the baby from slipping and falling at night, the mother while sitting in a fork, raised her legs about half as high as her body height and placed them on the vertical branch. The baby was thus held between the horizontal branch below and the mother's legs on either side. The mother in this position might rest her head on the baby's head and sleep. Some individuals rested their heads on their drawn up knees. The baby either sat close to its mother or clung to her. On waking, the langurs bared their teeth and jerked their heads forwards and backwards and again settled down to sleep. This act of teeth baring and head nodding was used in the same context as lip smacking among bonnets but might or might not be directed at any other individual (3). At night their eyes reflect red in a beam of light.

On a cloudy day they were still dozing on tree tops around 900 hrs, but on a sunny morning they were up and moving about by 600 hrs. While leaving the roosting place the dominant male might whoop. If they slept on a feeding tree, on waking up the next morning they moved on to the end of a branch and started to feed. The mother might nurse her infant a little before starting to feed.

Day Ranges

For the study of day ranges the activities of langurs were recorded from the time they left the roosting place till they settled down in another. Four major activities were recorded as in other primates.

(a) Movement

Langurs left the roosting places for feeding during the early hours of morning and vice versa during evening. On reaching a feeding tree, if the food was a preferred one like *Terminalia* or *Tamarindus,* they spent hours without visiting other food trees. Heavy showers sometimes impeded their movement. During group movement it was common for any monkey to move in any one direction and sit for a while before moving ahead and another individual very often came to the same spot and sat there before the former moved further on. This was continued till the whole troupe moved away. It appeared that owing to their habit of spreading out over wider areas than bonnets, this mode of progression, like a relay race, ensured that all the members of a troupe moved in one particular direction. A similar mode was often resorted to during tree progression too.

Some individuals, juveniles and mothers with young babies, avoided long leaps. Sometimes the baby playfully took the lead and the mother followed it, to be in turn followed by others, but this happened only on the ground. During movement, the one in the lead made way for the next individual by moving away, irrespective of age, sex or status. At times a part of the troupe remained behind in one core area while the other moved on to another. During progression all the individuals including young ones held their tails curled over their backs with the tip facing forwards and downwards. This physical pose was different from that of Dharwar langurs whose tails arched back with the tips facing down and to the rear. About 50 per cent of the area was covered by running during ground progressions. Sometimes they waded through water across streams.

(b) Feeding

The morning and evening hours were spent in vigorous feeding. The langurs fed on the leaves, fruits and flowers of a variety of trees and climbers (Table 2). The young ones were observed eating bark and tendrils. They ate pupae found on leaves. Usually tender leaves were selected but in the case of large leaves like those of *Wrightia,* the blades were stripped free of the mid rib and eaten while the latter was discarded. Likewise compound leaves such as of *Tamarindus* were stripped from the stalk. One or both hands were used in feeding. At times a slender branch was brought closer and held with one of the hind limbs while the leaves were released with fore limbs. If afraid of the observer, they would squat on a top branch, lean down stealthily to take a quick handful of leaves and went back to the old position and ate there. Long fruits like those of *Wrightia* were plucked and held in the hand and eaten candy-like, with short bites. Fruits of *Terminalia* were most preferred. They wasted a considerable amount of fruits but not leaves. Sometimes pupae were released from the leaves and then put into the mouth, or the mouth was applied directly to them. Once eggs of nesting birds were seen being eaten. On one occasion a female was noticed carefully watching a *Phalangium* on a Sterculia tree, but did not eat it.

As many as 4-5 individuals of different sex and status sat very close to one another and fed indicating the absence of competition for food. Sometimes they spent hours together in uninterrupted feeding. Though feeding might commence with dawn it reached a peak around 1000 hrs and again in the evening around 1700 hrs. During light showers the langurs continued to feed but heavy rain interrupted this activity. Even during the monsoon about 80 per cent of the langurs were seen drinking hence water consumption should be much more frequent in summer. This is contrary to what is reported for langurs elsewhere (Jay 1965). The water was taken by the mouth and the ani-

TABLE 2

LIST OF TREES AND CREEPERS ON WHICH LANGURS FED

Sl. No.	Local name	Scientific name	Part eaten
1.	Saajad*	*Terminalia crenulata*	Fruits and leaves
2.	Timbroo*	*Diospyros melanoxylon*	Fruits and leaves
3.	Doodhlo*	*Wrightia tinctoria*	Fruits and leaves
4.	Karapti	*Garuga pinnata*	Leaves
5.	Ambli*	*Tamarindus indica*	Fruits and leaves
6.	Ambra*	*Emblica officinalis*	Fruits and leaves
7.	Shisam	*Dalbergia latifolia*	Leaves
8.	Bawal	*Acacia arabica*	Flowers and leaves
9.	Jamboo*	*Syzygium rubicundum*	Fruits and leaves
10.	Kalukda	*Holarrhena antidysenterica*	Leaves
11.	Karamdi*	*Carissa carandas*	Leaves
12.	Behda	*Terminalia bellerica*	Leaves
13.	Vadlo*	*Ficus bengalensis*	Fruits
14.	Limbda	*Azardirachta indica*	Leaves
15.	Sarasda	*Albizzia odoratissima*	Leaves
16.	Saral	*Holoptelea integrifolia*	Leaves
17.	Ujad	?	Leaves and flowers
18.	Ron (Rohan)	*Soymida febrifuga*	Leaves
19.	Rhangari	*Morinda tinctoria*	Leaves and flowers
20.	Phangada	?	Leaves
21.	Kanthar	*Zizyphus* sp.	Leaves and flowers
22.	Saag	*Tectona grandis*	Pupae found on leaves
23.	Umbra*	*Ficus glomerata*	Fruits
24.	Ravano	*Syzygium cuminii*	Leaves
25.	Bel pathr*	*Aegle marmelos*	Fruits
26.	Kalum	*Mitragyna parvifolia*	Leaves
27.	Karung*	*Derris pinnata*	Fruits and leaves
28.	Kheria*	*Acacia catechu*	Leaves
29.	Kalukdo	*Holarrhena* sp.	Leaves
30.	Kadaya	*Sterculia urens*	Bark is rarely eaten
31.	Malvelo	*Combretum decandrum*	Leaves and flowers
32.	Dhamanah	*Grewia tiliaefolia*	Leaves
33.	Phagdovelo	Genus? Leguminosae	Leaves
34.	Gondovelo	*Vitis* sp.	Leaves
35.	Malkankana	*Celastrus paniculata*	Leaves
36.	Phankovelo	*Argyreia* sp.	Leaves
37.	Santovelo*	*Abrus precatorius*	Leaves
38.	Fagvel	*Rivea hypocrateriformis*	Leaves
39.	Phalli (Moong)	*Arachis hypogea* †	Leaves and flowers
40.	Bajra*	*Pennisetum typhodeum* †	Fruits
41.	Boona	*Gossypium* sp. †	Leaves

Note. * in fruit during the study period.
† Cultivated.

mal drank for about half minute. Sometimes the young baby from its clinging position lowered its head and lapped water.

(c) Social Grooming

A characteristic tactile stimulation that serves many purposes in primate society is grooming (Marler 1965). As in the case of bonnets there appeared to be considerable variation in the grooming frequency depending upon the time of day, reaching a peak when the sun was at its zenith. The grooming was indulged in when other individuals were inactively relaxing or dozing. For the purpose of grooming two or more individuals gathered and groomed one another. Sometimes there was self grooming as well. The mother groomed her infant and vice versa, a juvenile groomed another or a subadult or an adult. The grooming could thus occur in any one of the combinations irrespective of sex, age or status. The grooming was either of short duration, as in the case of a subadult grooming another or when grooming occurred on the ground. But it was of a considerably longer duration when a mother groomed her infant or an adult female groomed an adult male. The groomed animal might sit or lie down or doze while being groomed and shifted position exposing the desired parts to be groomed or the grooming animal itself fixed the position by pushing or pulling by the limb or neck or ear. The groomer very carefully scanned the area for dust particles and the like and on spotting one, picked it up by hand or put the mouth to it.

The desire to be groomed was expressed by an individual approaching another and making soft noises (*koon..koon..*) or by approaching and/or reaching out and holding a passerby by its limb or back. The latter invariably groomed the former. Sometimes the expression of this desire became more complex in dealing with an uncooperative partner. An adult female held a subadult female to be groomed. The latter skipped over the former and sat a few feet away. The adult female followed her and sat down close to her with her right leg resting on the latter's back. Once again the latter moved a short distance away, but the adult female persistently followed her and on reaching her gave her a gentle pat on her back. The subadult female turned and faced the adult female and was immediately embraced by her. The subadult female settled down to groom the adult female.

Sometimes the juveniles approached adult individuals and expressed their desire to groom by giving out a squeal but keeping a short distance away from them. They faced the animal that they wanted to groom and leaned forward squealing. If the latter expressed the desire to be groomed by exposing chest or loin, the juveniles immediately closed the distance and started to groom, but if the latter bared its teeth they backed away still squealing.

While grooming her infant, the mother held it pressed tightly against her, then stretched out a limb and groomed it. The baby might rest its head on the mother's lap and doze a bit while being groomed. Even if there were no parasites or dust, as indicated by the groomer not picking up and eating them, the mother continued to groom her infant for long periods. Mothers with young infants groomed more frequently than others and this might be due to reduced activity and movement by them.

The groomed animal sometimes stood upright on all fours and was groomed in the hind quarters. At times an open palm was passed over the body to part hair and occasionally both hands were used. The groomed animal to expose the chest and armpit and yet save strain on the hands, raised them and gripped an overhead branch. The tail being long and flexible was held in one hand while it was groomed with the other. The groomer probed even eyes and nose. Babies sometimes groomed their mothers and the female langur groomed more than the male. There were fewer grooming frequencies among langurs than bonnets and out of 51 instances of grooming observed, 23 occurred on the ground and the rest on trees. Many instances of self grooming and scratching were also observed. To scratch the region above the chest they generally used hind limbs and to scratch the region below the chest they used the forelimbs.

(d) Social Play

Social play was indulged in mostly by babies and juveniles. For the purpose, two or more individuals asssociated and were sometimes joined by subadults and adults. Play was either very brief or prolonged based upon the activity of other individuals of the troupe and other interferences. The peak period of social play coincided with the peak period of resting and social grooming by adults.

Play comprised a complex of whirling, jumping, chasing, somersaulting and swinging on slender branches etc. Play should be more important for a langur baby than for a bonnet as the former is more arboreal and taken less care of by its mother. Thus accommodating to its mode of life should depend more on itself and its activity than on any other agency or individual. It was obvious that even 3-4 month old babies, as determined by coat colour, could very easily negotiate vertical branches. The juveniles and babies spent more time in active play, feeding and moving than in dozing or grooming.

Hierarchy

Though a clearcut hierarchy was not observed, some individuals did behave in a more dominant manner than others. This was especially so with adult males and mothers with infants. An adult male at close approach of the observer came down to a lower branch and ground teeth while others sought shelter higher. On detecting danger or while leading the troupe the dominant male whooped and barked. Whenever there was a quarrel or a sudden and loud snapping of branch, it was the dominant male that rushed to the site. When the troupe was running on the ground and away from the observer it was he who ran last and resented the approach of the observer.

Likewise a mother with young infant expressed her dominance over others, especially the juveniles that harassed her infant, and successfully chased them away.

Even among juveniles some males appeared to be more dominant than others in that they were consistently watchful and it was these individuals that approached the observer as close as 20 yards and gave out squeals of resentment from a tree top. The squeal was given out by an individual that slouched forward, bared teeth and made trilling sounds accompanied by tail vibrations. On hearing such squeals some individuals approached closer to investigate the cause.

Troupe organisation was loose and lacked cohesiveness as they spread out over very wide areas while feeding or sleeping, with few(er) interactions between members. Hanuman langurs neither exhibit a strict functional ranking order nor a differentiation in their social organisation (Sugiyama & Parthasarathy 1969). But the fact that there were not many intertroupe fights and friction indicated the presence of a hierarchial system that minimised such encounters. But more observations are necessary on this aspect.

Mating and maternal behaviour

Mating behaviour and other social interactions were studied when the langurs were in the open. Langurs display sexual dimorphism in their physical build, males being very much bigger than the females. A total of nine mountings was witnessed during the study period. In eight of the nine copulations observed, the adult male initiated the mount as among bonnets (Simonds 1965) and on no occasion was a subadult male seen either mounting or even attempting. Only once was a female seen offering herself by shaking not only her tail as reported by Jay (1965) for common langurs of north India, but also the rump, and she was immediately mounted by the male. Once a male ground his teeth at an unwilling female, who after brief surrender dislodged the mounted male by lowering her hind quarters and running short distance. She was chased by him, but again she ran a short distance. The male ground his teeth and chased her again at which she surrendered herself and they copulated. Usually a female after being copulated approached some other individual and expressed her desire to be groomed.

Occasionally the copulation was interrupted by another female. On seeing the adult male mount an adult female, another adult female approached the pair and squealed bringing her snout close to that of the mounted female at which the latter lowered her hind quarters and forcibly dismounted the male. The females then ran away together.

None of the mounts observed were preceded by testing. The female held her tail awkwardly pushed between the legs of the male during copulation, while in the bonnet it was arched over the back and well out of the males' way. There was no instance of masturbation by langurs of either sex as in the case of Japanese monkeys of Taishaku-kyo (Imanishi 1957), in this aspect they differed from the howlers (Altman 1959) and bonnets (Rahaman & Parthasarathy 1968).

When the study was continued in July/August, most of the females had 4-6 month old babies that must have been born around January/ March. The peak period of births in langurs was from December to March (Sugiyama *et al.* 1965). Only one female in advanced stage of pregnancy was seen. Thus the langurs at Gir too had a peak period for breeding and the period more or less coincided with those for bonnets (Rahaman & Parthasarathy 1969) and rhesus (Southwick *et al.* 1965). This indicated two important features: (1) essential uniformity of the environmental factors in these three places (North, South and West) control the onset of mating and consequently births among these primates. (2) that these animals gave birth to infants during the period that enabled weaning to coincide with the monsoon season. Weaning during monsoon appears to have two advantages for the baby:– (a) it provides enough food in the form of tender leaves, flowers and a few fruits, (b) it ensures safety as it is during this period that the young one is left more to itself by its mother and is safer in the thick canopy of leaves than otherwise.

Young babies appeared darker in colour than the older ones. The dark babies usually clung to their mothers and suckled or slept holding the teat in their mouth. Mothers with such babies were inactive and spent less time feeding but more in resting and nursing the baby on top branches well concealed behind leaves. They usually avoided the close approach of the observer. At times small babies were left behind on trees when the mother moved away for food. On such occasions the babies screeched and tried to follow, but on failing to keep pace settled down to await their return. When she moved from one place to another, the mother carried the baby clinging to her belly and no instance of riding by the infants was witnessed. While progress-ing on the ground she led or followed it. When the mother was on the ground the baby mostly rested or suckled, or played with others. The baby stood on its hind limbs and reached for the teats when the mother sat on a high level. To prevent the baby from leaving her and yet facilitate the availability of both teats, the mother held the baby pressed between her body and one of the fore and the hind limbs while she raised the forelimb of the other side and gripped an overhead branch.

Though the baby fed on its mother's breast for a long period, the mother sometimes prevented it. On such occasions she just left the baby and moved away or jerked the nipple free or pushed the baby's head aside with her hand or hugged the baby in such a way that the mouth lost contact with the nipple. She sometimes bit the baby also. The 4-6 month old baby slept either clinging to its mother or pinned between her legs and branch or it might sleep a few feet away from her. On waking up the mother just extended her hand to the baby's direction and the latter moved and clung to her. The babies were seen biting at the bark and tendrils.

It appeared that the early mother-infant association among langurs was not intense but breast feeding continued for a long period. Young ones about a year old (obviously born the previous season) were seen suckling. Such individuals sat a little distance away from her, put their head forward and got at her nipples. Such individuals were only slightly smaller than their mothers. At times even juveniles were seen attempting to put their mouths to teats of adult females (probably mothers) after grooming them but were prevented by the latter.

In general the baby was readily allowed to mingle and play with other individuals. Often the mother abandoned the baby even at times of danger. A baby of Kapuria troupe was attacked by a hawk (*Accipiter* sp.). The mother that was on the ground, a few feet away, hastily made for safety. Sugiyama & Parthasarathy (1969) report that in the Hanuman langur the mother does not take special care and sometimes deserts the injured baby. This is unlike the maternal behaviour observed in bonnets (Rahaman & Parthasarathy 1969). On a rainy day a langur baby was left behind by the mother. Such babies were usually accompanied and escorted by other individuals. When the mother was on the ground, the baby separated itself from the mother and played with other individuals or objects available. For most of the time the baby kept making trips to and from the mother. These trips were short and brief when the baby was alone (about 20 trips were made in 3 mts. by the baby once) but they were prolonged in time and area in the company of others (one trip took about a minute). A young baby has a springy gait and holds its tail as do the older ones.

The mother on spotting the observer made a neighing sort of sound to call her baby. She sometimes tolerated other individuals handling it but at the same time resented it. In fact the attitude of the mother towards other individuals handling her baby depended mainly on their approach. If the approach was straight and bold as with adult individuals, the mother did not object them. But it was fidgety and playful as with the juveniles, she resented their approach. Sometimes a mother objected to one female taking liberties with her baby while she readily tolerated another. A mother after being groomed by a female was grooming her in turn. The latter took the former's baby and hugged it. Another female approached the one that was hugging the baby and reached for it playfully. The mother with a snort chased the intruder away. Sometimes even the infant does not like being handled by others. The mother at times slapped juveniles that tried to play with her baby. Even the baby acted sometimes similarly.

The babies readily recognised their mothers and went only to them at times of need. Three mothers were once seen engaged in mutual grooming on ground while their babies were at play a short distance away. The relative positions of the mothers were marked and then a panic was created among them by a person suddenly rushing at them. The mothers ran helter-skelter but the babies ran only to their respective mothers without any confusion.

Interspecific interactions and predation

On two occasions langurs were witnessed feeding in close proximity with the monitor (*Varanus* sp.) and once with a mongoose (*Herpestes* sp.), but with no interaction from either side. But on certain other occasions they were seen to be distinctly associated with and to interact with other animals.

On two occasions when some birds (unidentified) took panic and flew for some unknown reason, the langurs feeding close by scampered up the treeposte haste. During ground progression the Talala road troupe was once seen closely following a pair of peafowl, apparently to be forewarned of any danger. Incidentally it was noticed that the peahen was more wary than the peacock. When the langurs took panic the peafowls took to flight and vice versa.

Once on finding the author blocking its way, a squirrel (*Funambulus* sp.) gave out a continuous chrip from the bole of the tree. Three adult langurs came out to investigate the reason. On one occasion a young langur tried to catch a squirrel that was avoiding and approaching the langur carefully. After the fourth attempt, the langur gave up and moved away.

Halfway between Shirvan and Amrutvel a herd of chital, *Axis*

axis (1 male and 4 females) was seen feeding under a ficus tree occupied by langurs. The langurs were the first to spot the observer and dash off along the tree top. The chital immediately bolted without attempting to find out what had disturbed the langurs. They stopped some hundred yards away and then faced the direction from which they had fled to investigate the cause and on finding the observer they vanished. Such association had twofold benefits for the chital, in that the langurs not only informed them of any lurking danger but also provided them food in the form of dropped fruits etc. Such associations between langurs and chital have been repeatedly observed by Starin (personal communication) especially during summer months when the chital are likely to depend more on langurs for food with the grass drying up. The deer if undisturbed would feed in the company of langurs for hours together as could be made out by the absence of dropped leaves, fruits and the like and the large amount of faecal pellets dropped by them. In south India such associations between deer and bonnet macaques have been recorded by me.

Leopards (*Panthera pardus*) were common in the study area and were on several occasions heard from close quarters, which disturbed langurs. Obviously the langurs were preyed upon by them. The lions (*Panthera leo persica*) were reported to kill langurs occasionally. During the study period two village dogs killed and ate a subadult male langur from the Chitrode troupe. When the monkey was caught on the ground by the dogs, the dominant male gave out a bark of alarm and a subadult female gave a wailing cry. But after two minutes of the incident they settled down and were calm. However every time the dominant male viewed the site of the carcass being torn by the dogs he ground his teeth.

On July 30, 1971, an adult female langur was killed by a python (*Python molurus*) near Bhojde. When the snake was in the act of swallowing it, the villagers saw this and decapitated the snake in an attempt to save the monkey, which was by then dead.

Once a hawk (*Accipiter* sp.) was observed attacking a baby langur of the Kapuria troupe. The baby was on the ground and a few feet away from its mother. On the approach of the bird the mother sought shelter without rescuing the baby. The dominant male sitting on a high branch rushed to the site and his jump on to the lowermost branch jerked it in such a manner that it brushed against the bird and prevented it from taking hold of the baby. After the bird flew off the mother collected her baby.

Jungle crows (*Corvus macrorhynchus*) at times descended in number in the feeding locality of langurs to feed upon insects displaced by the langurs.

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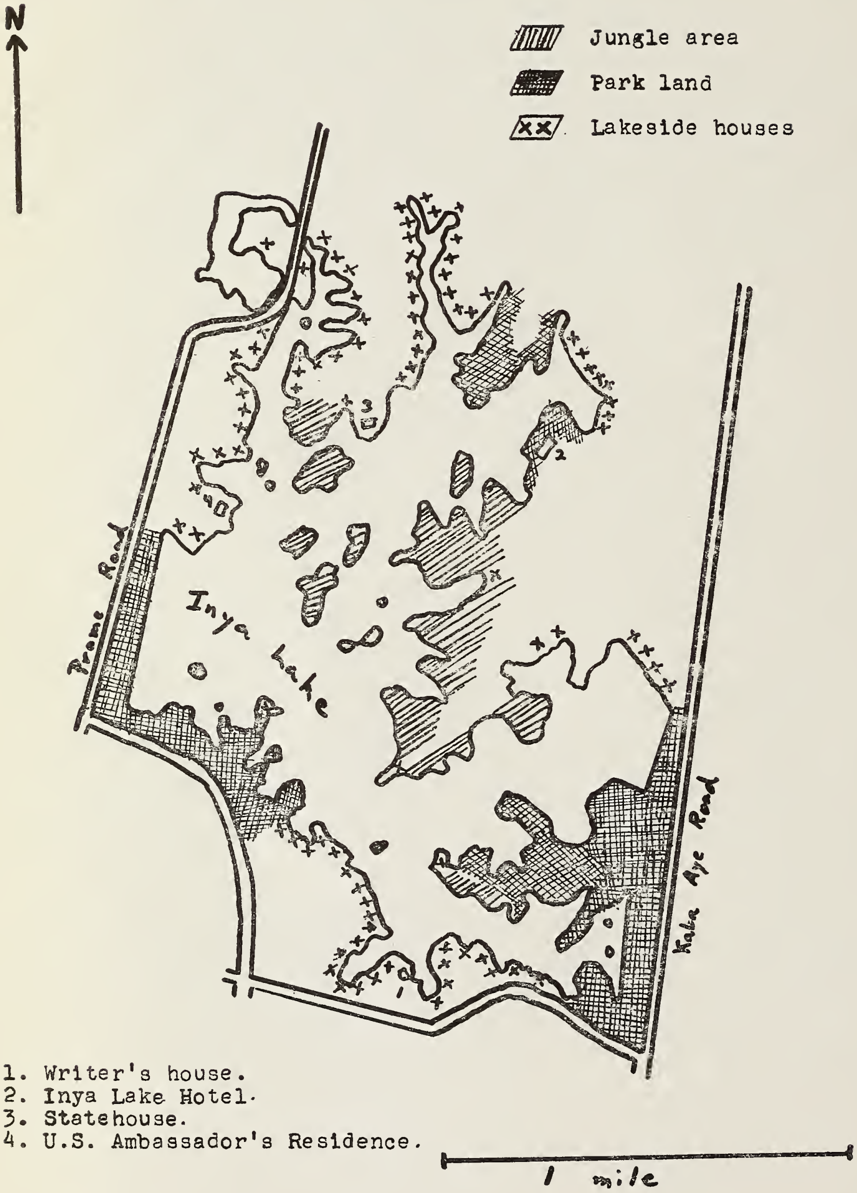
INYA LAKE


N
▨ Jungle area
▨ Park land
XX Lakeside houses
Prome Road
Inya Lake
Kaba Aye Road
1
2
3
4
1 mile

1. Writer's house.
2. Inya Lake Hotel.
3. Statehouse.
4. U.S. Ambassador's Residence.

The Birds of Inya Lake, Rangoon, Burma[1]

BY

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(*With a map*)

There has been little in the way of serious bird study in Burma during the last decade, and so far as I could ascertain no published work on the birds of Rangoon since H. H. Harington's contribution, "Some Rangoon Birds" *J. Bombay nat. Hist. Soc.*, **19** in 1909. Believing that future ornithologists in Burma might be interested in noting any change in the pattern of bird species in a representative area of Burma's capital, my son Mark and I undertook for three years a survey of the birds on and about Inya Lake.

One of Rangoon's most attractive landmarks, this lake measures about 2 by 1.5 miles, has a shoreline of probably 10 miles, and a water area of perhaps 2 square miles. Built as a reservoir for Rangoon in the 1880's, the lake shore is bordered by jungle, park land, Burma's biggest hotel, and some of Burma's finest residences (including the temporary Statehouse of General Ne Win).

I was fortunate to live in one of the houses bordering the lake, and to have access to its waters by canoe and sail boat. All its many bays and coves were visited at one time or another, but considerations of distance restricted the most thorough coverage to shore areas within half a mile of my home. Over the three years July 1968 to July 1971, we averaged one bird outing every three weeks.

Though we can only claim to have identified 82 species, we believe that given time and patience the lake area and its environs might have revealed a population of between 100 to 125 species. These figures may, however, never be attained because Rangoon's suburbs creep ever outwards, the parkland and waters of the lake are becoming more crowded with visitors, and the jungle areas are being ravaged by illicit woodcutters and by guard houses covering the approaches to the Statehouse. Fortunately, hunting and motorboats are not allowed on the lake.

Perhaps the most interesting feature of the area's bird population has been its migratory character. Probably less than one quarter of

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[1] Accepted July 21, 1971.

the species are truly resident, the remaining being seasonal visitors. There are roughly three bird seasons: the dreary, wet monsoon period (June to September) when the number of species drops to its yearly low; the fall season (October to January) when the lake is visited by many migratory species from the north; and the hot, dry season (February to May) when birds from the parched countryside visit the lake. Some migratory birds from the north not seen in the fall also visit the lake during this last season.

In terms of sheer abundance, the House Crow and Common Myna clearly lead the field. Rangoon is notorious for its crows, and several thousand roost at night in high trees around the lake. Next to these two species, probably the most common are the Tree Sparrow, Indian Pond Heron, Lesser Whistling Teal, Black Drongo, and Little Cormorant.

The survey unearthed few distributional tidbits for science. The only possible contributions are two additions to the distribution of birds in the plains area of lower Burma, as given in the chart in Smythies' THE BIRDS OF BURMA (1953). These are: the Chestnut-headed Bee-eater; and the Daurian Starling. The former is a regular annual winter visitor to the lake. Its omission from Smythies' chart may have been inadvertent since he mentions its being encountered at Hlawga Lake which is just outside the city. A flock of Daurian Starlings was seen once by me on one of the jungle islands in the lake, and it may be an occasional visitor. According to Smythies, the Daurian was a rarity in the plains, having been sighted only once, in Pegu, a city 55 miles from Rangoon.

Three somewhat puzzling omissions from my bird list should be mentioned: the Redvented Bulbul (*Pycnonotus cafer*); the Paddyfield Pipit (*Anthus novaeseelandiae*); and the Brownheaded Gull (*Larus brunnicephalus*). The first two are common on the outskirts of Rangoon, while the Gull is abundant during the winter months on the Rangoon river. We never found them about Inya Lake.

Podiceps ruficollis Little Grebe

Common seasonal visitor. Usually encountered only in the easternmost arm of the lake where it is abundant from January to May. As many as 100 were seen at one time. Often seen in association with Lesser Whistling Teals which rest in the same inlet. Disappears during the monsoon.

Phalacrocorax niger Little Cormorant

One of the commmonest birds on the lake from September to May. Disappears during the monsoon months. Usually seen singly or in small, loose groups but flocks of 40 or so have been counted swimming together in November. Rests at night in flocks of about 20 in small lakeside trees, often in company with Darters.

Anhinga rufa melanogaster Darter or Snake-bird

Common on the lake during the dry season, September to May. Usually seen singly. Roosts at night with Little Cormorants. Disappears during the monsoon. Can be approached to within about twenty yards. Exciting bird to watch at all times.

Ardea cinerea Grey Heron

Occasional visitor. Encountered only three times, twice in January and once in May. Once it was perched on a lakeside tree; the other two times it was standing in shallow water adjacent to small grass-covered islands.

Butorides striatus Little Green Heron

Probably occasional visitor. Seen only once in March 1969, when a flock of three were seen perched on low branches overhanging the lake on a jungle-fringed narrows.

Ardeola grayii Indian Pond Heron

Probably a resident. One of the most common birds on the lake-shore, from October to May. Uncommon during the monsoon.

Bubulcus ibis Cattle Egret

Seasonally common, from January to May. During this period, a flock of as many as 20 can be seen feeding on the spacious lake-side lawn of the American Ambassador's residence.

Egretta alba Greater Egret

Common only in the dryest months, March to May. Occasionally seen during the monsoon.

Egretta intermedia Intermediate Egret

Occasional visitor. Is the least common of the Egrets.

Egretta garzetta Little Egret

Very common during the dryest months, March to May. Not often seen at other times. The evening flights of these to their roosts is always a lovely sight.

Nycticorax nycticorax Night Heron

Probably a resident. A small flock of about 20 birds lives on two tiny jungle-covered islands in the lake. Most commonly seen from September to December.

Ixobrychus cinnamomeus Cinnamon Bittern

Probably a resident. Common from March to May in reed and water hyacinth-fringed inlets. Usually seen only in the very early morning. Much less frequently at dusk.

Ixobrychus sinensis Yellow Bittern

May be resident. Single birds regularly encountered from March to May in late afternoons in rush and water hyacinth shore areas and islands.

Dupetor flavicollis Black Bittern

Uncommon. Encountered only in October and November in early morning and at dusk on edge of jungle islands.

Botaurus stellaris Bittern

Uncommon visitor. Encountered only once, in April, when two were flushed from reedy islands in the lake.

Dendrocygna javanica Lesser Whistling Teal

Very common from January to May. Always in flocks which number up to 300 birds. Always very wary and difficult to approach. At dusk and early evening, commonly heard flying and calling over the lake.

Nettapus coromandelianus Cotton Teal

Common from March till May where water plants are abundant. Seems to be increasing annually. Often seen in loose flocks of up to 20 birds.

Elanus caeruleus Blackwinged Kite

Probably an occasional visitor. Seen once in February.

Milvus migrans Pariah Kite

Very common from October to May but most abundant from November to December. Roosts at night in trees on some of the jungle islands. Disappears during the monsoon.

Milvus (migrans) lineatus Blackeared Kite

Appears also to be common but not easily distinguishable from above species. Same habits and habitat.

Accipiter badius Shikra Goshawk

Uncommon. Seen in September and October in garden trees along the lake shores, often being harassed by crows.

Gyps bengalensis Whitebacked Vulture

Uncommon. Single birds seen on two occasions in winter months resting in tall lakeside trees and being pestered by crows.

Pandion haliaetus Osprey

Uncommon from October to April. Seen flying over lake or resting on some lakeside tree.

Amaurornis phoenicurus Whitebreasted Waterhen

Common. Often seen from November to June along lakeshore.

Gallicrex cinerea Watercock

Common. Single birds can be seen at dawn or dusk in marshy inlets from March to May.

Gallinula chloropus Moorhen

Uncommon visitor. Single birds seen in April in reedy, shallow portions of the lake.

Hydrophasianus chirurgus Pheasant-tailed Jacana

Common from January to May. Sometimes seen with next species. Seems to be increasing in population on the lake. In breeding plumage with its long tail, it is particularly attractive. Always lovely in flight with its pied wings.

Metopidius indicus Bronzewinged Jacana

Very common from January to June in every marshy inlet. Less shy and more abundant than above species. It also seems to be growing in population.

Charadrius dubius Little Ringed Plover

Uncommon visitor. Seen only in March and April at the height of the hot, dry season when mud-flats sometimes appear in the lake. Singles and pairs seen.

Tringa glareola Wood Sandpiper

Seasonal visitor in April and May at the height of the dry season, when it is not uncommon on mud-flats on the lake.

Tringa hypoleucos Common Sandpiper

Commonly encountered from September to April. Usually seen singly along the shores of the lake and around tiny islands.

Chlidonias hybrida Whiskered Tern

Regular visitor from December to April. Usually seen in pairs or threes quartering the lake. Never seen at rest.

Gelochelidon nilotica Gullbilled Tern

Regular seasonal visitor from February to April. Seen singly and in threes, always in flight over the lake.

Streptopelia chinensis Spotted Dove

Resident. Common garden bird in the villas surrounding the lake.

Cuculus canorus Cuckoo

Occasional. Seen in October and December.

Cacomantis merulinus Plaintive Cuckoo

Possibly a resident. Common from January to July, particularly from March to May when its distinctive call is frequently heard.

Eudynamys scolopacea Koel

Possibly a resident but commonly heard only from October to April, particularly on small jungle-covered islands. Hard to spot. Usually keeps to thick canopy of tall trees.

Centropus sinensis Greater Coucal

Probably a resident on the jungle-covered islands where it has been encountered throughout the year.

Tyto alba Barn Owl

Occasional. Its screech is heard from time to time in lakeside gardens in winter months.

Strix seloputo Spotted Wood Owl

Occasional. Heard and seen while flying over a lakeside garden in March.

Cypsiurus parvus Palm Swift

Resident. Groups flying are a common sight year round along the lakeshore.

Ceryle rudis Lesser Pied Kingfisher

Occasional visitor. Encountered only in April and May. Spectacular diver.

Alcedo atthis Common Kingfisher

Seasonally common, from September to March, along the lake shore.

Halcyon smyrnensis Whitebreasted Kingfisher

Often encountered from August to April. Most common kingfisher on the lake. Noisy. Usually seen perched on some branch overhanging the lake.

Halcyon pileata Blackcapped Kingfisher

Uncommon visitor. Only seen once, in October, perched on a lakeside tree.

Merops leschenaulti Chestnutheaded Bee-eater

Uncommon but regular visitor. Small flocks of 3 to 6 birds seen from October to February on two jungle islands.

Merops philippinus Bluetailed Bee-eater

Uncommon but regular annual visitor. Small flocks occasionally encountered from September to April, hawking from lakeside trees.

Merops orientalis Green Bee-eater

Common, perhaps a resident. Seen all year round, usually found perched in small flocks on lakeside trees.

Coracias benghalensis Burmese Roller

Common, from September to May in lakeside gardens.

Upupa epops Hoopoe

Occasionally encountered in October and November in lakeside gardens.

Megalaima haemacephala Crimsonbreasted Barbet

Resident. One of the most common garden birds, more often heard than seen.

Hirundo rustica European House Swallow

Common from September to May, particularly from January to April. Singles and groups often seen flying over the surface of the lake hawking for insects.

Lanius cristatus Brown Shrike

Common garden bird from October to April.

Oriolus tenuirostris Slender-billed Oriole

Annual visitor but uncommon. Small flocks occasionally encountered from October to April in canopy of lakeside trees.

Dicrurus adsimilis Black Drongo

Very common, from September to April. One of the most familiar garden birds. Disappears during the monsoon months.

Dicrurus leucophaeus Ashy Drongo

Uncommon. Singles seen occasionally on jungle islands from October to February.

Artamus fuscus Ashy Swallow-Shrike

Uncommon. Seen only in July and August perched on high, exposed limbs of trees in lakeside gardens.

Sturnus malabaricus Ashy-headed Starling

Common in flocks of 20-30 birds from mid-November to mid-February.

Sturnus sturninus Daurian Starling

Occasional visitor. A flock of about ten birds encountered once, in mid-April, in trees in open section of a jungle island.

Sturnus contra Pied Starling

Commonly encountered in April-May and again in September along the lakeshore. Usually found close to water's edge.

Sturnus tristis Common Myna

Resident and abundant. Shares with the House Crow the distinction of being one of the two most common birds in the lake area. Almost always seen in pairs.

Sturnus javanicus Jungle Myna

Commonly encountered from March through June in meadow parkland fringing the lake. Rarely met in gardens.

Corvus splendens House Crow

Abundant and a conspicuous, noisy bird at all seasons. Every garden has them and at night they roost in thousands in high trees in certain areas fringing the lake.

Tephrodornis pondicerianus Common Wood Shrike

Occasional visitor. Encountered only once on top of lakeside tree in September.

Aegithina tiphia Common Iora

Uncommon visitor. Encountered only in March and April in lakeside gardens in trees and big shrubs.

Pycnonotus melanicterus Black-crested Yellow Bulbul

Common in small flocks in November and December on jungle islands.

Pycnonotus blanfordi Blanford's Olive Bulbul

Common in small flocks from March to May in garden trees and on jungle islands.

Muscicapa parva Red-breasted Flycatcher

Very common in garden trees and shrubs from October to February. All disappear by April. Except in late March, the bird is always seen in its drab brownish-grey winter plumage.

Phylloscopus inornatus Yellow-browed Willow Warbler

Uncommon. Pair encountered only once in November on jungle island.

Phylloscopus inornatus Yellow-browed Willow Warbler

Uncommon. Seen only once, a pair, in October, in canopy of garden tree.

Orthotomus sutorius Common Tailorbird

Common resident in lakeside gardens and on the more open jungle islands. More often heard than seen.

Copsychus saularis Magpie Robin

Common resident in lakeside gardens and in open parkland fringing the lake.

Monticola solitarius Blue Rock Thrush

Uncommon visitor. Encountered only in March in lakeside gardens.

Motacilla alba Pied Wagtail

Common from October to January. Never seen at other times. Visits lawns of lakeshore gardens.

Motacilla caspica Grey Wagtail

Least common of the three Wagtails. Singles seen occasionally from September to November on lawns.

Motacilla flava Yellow Wagtail

Most common of the Wagtails and often encountered from October to May, on lakeshore lawns. Is most common from February to March.

Prionochilus thoracicus Scarlet-breasted Flowerpecker

Uncommon. Pairs encountered only in April on jungle islands.

Passer montanus Tree Sparrow

Resident and very common around every lakeside home.

Ploceus philippinus Baya Weaverbird

Common from March to June, especially on rushes along the lakeshore. Nesting area was not found.

Lonchura punctulata Spotted Munia

Common from March to May in groups of as many as 20 birds in lakeside gardens. Occasionally seen during the monsoon months through to October when it disappears.

Lonchura malacca Chestnut Munia

Less common than above species, and never seen in large groups. Two to three birds is usual. Encountered from March to August, but most commonly during April to June when it nests in shrubs around lakeshore houses.

Emberiza aureola Yellow-breasted Bunting

Uncommon visitor. Encountered only in April along lakeshore: once a pair was seen in a small tree overhanging the lake on a jungle island; and a single was met a year later perched on a marsh plant in an inlet.

A new Species of *Ischaemum* Linn. from India[1]

BY

R. B. PATIL[2] AND R. D'CRUZ[3]

Botany Section, College of Agriculture, Poona 5

(*With a plate*)

Ischaemum vembanadense sp. nov. (Poaceae) is described and illustrated.

Ischaemum vembanadense sp. nov.

I. magno Rendle similis sed differt caule et ramis omnino serpentibus, spiculis sessilibus minus quam 7 mm. longis, pedicellis et rhachidibus permitus glabris, ligula integra et spiculae pedicellatae gluma inferiore ad unam marginem late alata.

Ischaemum vembanadense sp. nov. (Figs. 1-7)

Allied to *I. magnum* Rendle but differs in the completely trailing or prostrate stem and branches, the sessile spikelet which is less than 7 mm long, the completely glabrous pedicel and rachis, the entire ligule and the lower glume of the pedicelled spikelet which has a broad wing on one margin.

A perennial grass, oulms 150-160 cm, completely glabrous and smooth, densely tufted; trailing or prostrate, branching from each node, branches prostrate, nodes glabrous and tumid, internodes heavily prunose. Leaf blades up to 15 cm long, 1 to 1.5 cm wide, acuminate, lower leaves tapering to the base; upper sub-cordate with a small hairy petiole, ligule 0.5 to 1 cm long, entire and hairy on the margins, sheath loose slipping from the culms and open at the top with ciliate or hairy margins at top. Inflorescences two, appressed, not more than 7 mm long, lower two joints of rachis confluent, joints of rachis trigonous, smooth all over, pale yellow. Sessile spikelet: *Lower glume* 6.5 to 7 mm long; 1.5 to 2 mm wide; oblong-acute in shape, coriaceous-crustaceous

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[1] Accepted July 21, 1971.

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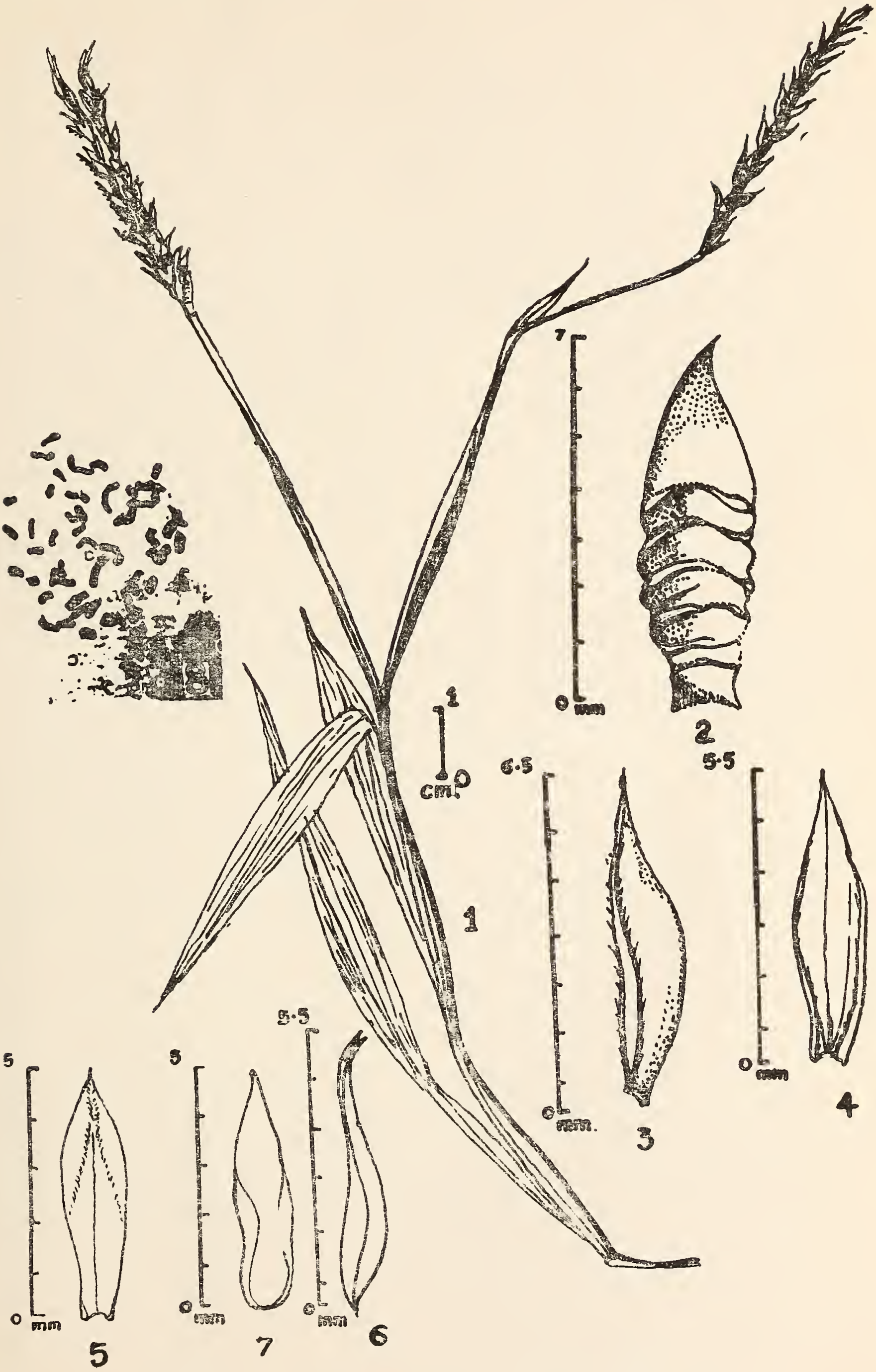

Ischaemum vembanadense Patil et D'Cruz (Figs. 1-8).
1. A portion of culm with leaf and inflorescences; 2. Lower glume of sessile spikelet (dorsal); 3. Upper glume of sessile spikelet (side view); 4. Lower lemma of sessile spikelet (ventral); 5. Palea of sessile spikelet (ventral); 6. Upper lemma of sessile spikelet (side view); 7. Palea of sessile spikelet (ventral); 8. Mitotic metaphase of $2n = 50$.950 X.

in the lower half, herbaceous above with numerous fine green nerves, lower half smooth; transversely and irregularly wrinkled; margins narrowly incurved from base to apex, ventral side with greenish red tinge in the lower 3/4 portion. *Upper glume*: 6.5 to 7 mm long; 1 mm wide; glabrous; boat shaped, strongly keeled with incurved and ciliate margins. *Lower floret*: ♂, *lemma hyaline;* 6 mm long; oblong lanceolate, 3 nerved, margins slightly ciliate and keeled, *palea* about 5 mm long; hyaline strongly keeled on margin; margins slightly ciliate. *Upper floret*: ⚥, *lemma* 5mm long, boat shaped; ciliate on the margins, cleft in the middle with or without awn, *palea* membranous 4.5 mm long; *stamens* 3, *anthers* 3 mm long, *styles* 2, stigmas plumose and whitish yellowish when young. Pedicelled spikelet: Pedicel triangular in section, stout; 2 mm long, not ciliate on outer angle. *Lower glume*: 6 mm long, with 3-5 nodules on inner margins; *upper glume* strongly keeled in the lower half, glabrous, ciliate on the margins, chartaceous-herbaceous in texture. *Lower floret*: ♂, *stamen* 3, *anthers* 2.5 mm long, *lemma* 6 mm long, oblong-acute, ciliate on the margins, *palea* 4.5 mm long, hyaline strongly keeled. *Upper floret*: ⚥, *stamens* 3, *anthers* 2.5 mm long, *styles* 2, stigmas plumose, *lemma* 4.5 mm long, hyaline, 3 nerved, mucronate, *palea* 3 mm long, hyaline.

Holotype collected at Allepy backwaters, Kerala, India by Patil on 10th January 1970 and deposited in the Herbarium, Botany Section, College of Agriculture, Poona 5 under the field number I-919. Isotypes to be deposited in Herbarium at Botanical Survey of India, Western Circle, Poona-1.

Etymology: This taxon is named after the well known lake "Vembanad" in Allepy District, Kerala, India. The root tip study in this species gave somatic count of $2n = 50$ chromosomes (Fig. 8). Meiosis was abnormal but seed setting was normal.

ACKNOWLEDGEMENTS

This research has been financed in part by a grant made by U.S.D.A. under P.L. 480 Research Project A7-CR-130. Our grateful thanks are also due to Rev. Fr. Cecil J. Saldanha, Principal Indian Investigator, Hassan Flora Project, St. Joseph's College, Bangalore for kindly translating the diagnosis into Latin.

Notes on the Nest and Behaviour of the Yellowbrowed Titmouse, *Parus modestus* (Burton)[1]

BY

ROBERT L. FLEMING, JR.

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The Yellowbrowed Titmouse, *Parus modestus* (Burton), is distributed widely through mountainous country from Kashmir east to Fukien in south China (Ripley 1961:553). Although usually considered uncommon, this species is met frequently in the oak forests of Nepal where it would appear to be overlooked rather than rare (see Fleming & Traylor 1968:185).

Little is known about this bird; the nest has not been described (see Ali 1962:342-343). Since this titmouse resembles a leaf warbler (*Phylloscopus*) in both size and colour, some authors have placed it in a distinct genus, *Sylviparus,* to indicate its affinity with the warblers. Other workers, noting this bird's typical titmouse behaviour, have retained it in the genus *Parus.*

The nest of this bird is of special interest. Nest building is usually a highly stereotyped behaviour pattern and the way the nest is constructed is often a strong indicator of phylogenetic affinity. *Sylviparus* advocates believed the nest would be of a warbler type: a ball of moss not secreted inside a hole (see Disselhorst 1968:349). The *Parus* people felt that the nest would be typically titmouse: a pad of hair or feathers placed in a natural cavity either in a tree or in the ground.

The first Yellowbrowed Titmouse nest was discovered on 4 May, 1968, in a hole of a rhododendron tree at 2378 metres (7800′) elevation on Phulchowki, Patan District, Central Nepal. The nest was found by Mr. and Mrs. Gene Boster and their daughter Barbara, of the U.S. Embassy, Kathmandu.

My father, Dr. Robert L. Fleming, Sr., regularly organizes bird walks for the residents of Kathmandu; on one of these excursions this first nest was discovered. We already had determined that the nesting season of this titmouse was in April and May and that Phulchowki

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[1] Accepted August 14, 1972.

fell within its breeding grounds, but following the small birds from tall oak to tall oak and across steep hillsides proved difficult. The 4 May trip was one of many that had been aimed at finding this nest.

On 5 May we observed the titmice for a period of 4 hours and 17 mins. beginning at 0845. During this time, the parents fed the young a total of 114 times. The feeding frequency was: 0901 to 1000—19 visits; 1001 to 1100—20 visits; 1101 to 1200—25 visits; 1201 to 1300 —46 visits.

Consistant behavioural differences in the two parent birds were noted. One bird, presumably the male, was more timid than the other; it also appeared larger than the second. The first bird sang frequently and, if in the company of the second, often shivered its wings in a courting routine. The male approached the nest in the following fashion: overhanging branch to bush, two or three position shifts in the bush and then to the nest. The female approach pattern was: overhead branch to bush to tree trunk to nest. She did not pause long at each stop. If the female appeared at the nest while the male was outside, shifting positions and hesitating to go in, she would dart past him and quickly feed the young. After she left, he would enter.

Only once were the two birds noted in the nest hole together. On this occasion, the male was already in the nest when the female arrived in her rapid approach pattern and quickly disappeared inside. Several squeaks later, one bird (sex undetermined) exited with considerable speed.

Ninety-nine visits to the nest were recorded after the probable sex of each parent was established. Of these, 51 were by the male, 43 by the female and 5 undetermined.

Light rain began at 1034 and continued until 1052. During this period, the young were visited 8 times with no apparent let up in feeding frequency.

Food items were identified on 65 trips. Light green, apparently hairless larve, approximately 1 cm long were fed 64 times. Only one caterpillar was brought per trip. A katydid, also light green, was fed once.

The birds were not silent around the nest site. The male sang lustily from both the overhanging branch and the bush near the hole. Its "song" consisted of a high, squeaking *tee* repeated between 5 and 8 times in a 5 second period. The alarm call was a very high pitched, buzzy, *tzee tzee*. Occasionally the male appeared to wait near the nest for the female. He would sing loudly and when she arrived, he would court her with much wing shivering. The female also shivered once, briefly.

When agitated or excited, the titmouse erected its diminutive crest; at this time the yellow eyebrow was clearly visible at close range.

Thus the eyebrow is seen during courtship as well as when the bird is scolding intruders.

The entrance hole to the nest, a natural, vertical slit about 45 mm long by 17 mm wide at the widest point, was located 42 cm from the ground. The opening was so narrow that the birds had to flatten vertically and then push themselves against the side of the tree to get in. The nest was in a *Rhododendron arboreum* tree that was growing in fairly open oak (*Quercus semecarpifolia*) forest with a light understory of viburnum, barberry, daphne, symplocos, and strobilanthes.

The nest was not thoroughly examined as we did not wish to endanger the young. Using flashlights and dental mirrors, we counted four young on a pad about 15 cm below the bottom of the entrance slit. The young appeared to be nearly ready to leave the nest.

The second Yellowbrowed Titmouse nest was found on 25 April 1972; it contained eggs. This nest was discovered by Professor Richard S. Morgan of Pennsylvania State University. Professor Morgan was resting quietly beside a moss covered boulder at about 2488 metres (9800′) elevation on a trek to Ganesh Himal (Rasuwa District, Central Nepal) when he noticed a small bird disappearing into an astoundingly small hole in a tree. This was the nest opening.

This nest was placed about 6 m (20′) above the ground in a maple (*Acer*) tree. This particular maple divided into three major "trunks" about 2 metres above the ground; the nest was located in the trunk that leaned farthest away from the hillside. The degree of lean was estimated at about 20 degrees from vertical. The selected tree stood in a relatively open part of a mixed forest consisting of fir (*Abies spectabilis*), hemlock (*Tsuga dumosa*), oak (*Quercus semecarpifolia*) and rhododendron (*R. arboreum* and *R. barbatum*).

The opening of the nest was again in a natural cavity; it measured 50 mm vertically by 17 mm wide at the widest point.

On this occasion the tree was cut open so that the nest could be examined carefully. Unfortunately the location of the nest made it difficult to enlarge the opening sufficiently to extract the contents. Eventually the nest was removed but all the fragile eggs were broken in the process.

The nest pad lay about 20 cm below the entrance in a natural cavity that slanted diagonally towards the center of the tree. The nest entirely filled the lower part of the cavity. The top of the pad, which stretched from wall to wall, was about 10 cm across. The eggs were placed on a top layer constructed entirely of fur which measured about 5 mm thick. The next layer, of about 10 mm depth, was fur mixed with a little soft, brown moss. Underneath this "crown", and filling the entire cavity down to the base (about 15 cm), was soft, green moss mixed with a little fur.

The reddish fur, some hairs tipped with white, of the Giant Flying Squirrel (*Petaurista petaurista*) was used in the nest. The birds apparently found a dead squirrel for some of the fur had come away in small clumps with the skin still attached. A small amount of grey fur, apparently from a Vole (*Alticola*), was used in the second layer of the nest.

There appeared to have been six eggs in the clutch. The fragile shells were white without noticeable blotches. Titmice often have faintly to boldly marked eggs so it was surprising that no markings were detected on these fragments.

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Orchids of Nepal[1]

BY

M. L. BANERJI[2] AND B. B. THAPA[3]

(*With four text-figures in a plate*)

This instalment on the orchids of Nepal deals with the genera that are placed under the tribe Polychondroideae, the subtribes are indicated accordingly e.g. *Listera* (Listereae), *Cephalanthera* & *Epipactis* (Cephalanthereae), *Arundina* & *Thunia* (Sobralieae), *Nervilia* (Pogonieae), *Spiranthes* (Spirantheae) and *Herpysma, Goodyera* and *Zeuxine* (Erythroideae). The genera are arranged alphabetically.

ARTIFICIAL KEY TO THE GENERA

A. Stem with a thick underground part or a pseudobulb, or a stout subtuberous rootstock —
  B. Inflorescence terminal; lip sessile not spurred, base concave and embracing the column. Terrestrial herbs, stem leafy, leaves distichous .... *Arundina*

  BB. Inflorescence lateral. Lip spurred, sidelobes embracing the column .... *Thunia*

AA. Stem not bulbous, roots often bulbous —
  C. Stem simple, erect, roots tuberous —
    D. Spur long, lip exposed beyond the base of the lateral sepals .... *Herpysma*

    DD. Spur short i.e. saccate, lip flat —
      E. Lateral sepals not free; spike dense flowered and spiral; leaves several .... *Spiranthes*

      EE. Lateral sepals free —
        F. Two leaved herbs .... *Listera*

        FF. Many leaved herbs —
          G. Lip clawed beyond the spur, column with two linear appendages in front; stigmas 2 ..... *Zeuxine*

          GG. Lip not clawed beyond the spur, column not appendaged; stigma 1............ *Goodyera*

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[1] Accepted August 31, 1972.

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CC. Stem simple, erect from an underground tuber; 1—leaved; sepals erect or spreading; column elongate not winged....... *Nervilia*

CCC. Stem simple, erect from an underground rootstock, leafy, leaves plicate—
D'. Sepals conniving; lip hidden by the sepals, not clearly divided into epichile and hypochile ....*Cephalanthera*

D'D'. Sepals free, spreading; lip clearly divided into epichile and hypochile. Anthers dorsal, caudicle rudimentary ....*Epipactis*

Arundina Bl.

These are terrestrial orchids some 1.5 to 2.0 m tall and having reed-like stems because of which the genus gets the name. Leaves are numerous, membraneous and narrow. Flowers are large in racemes with petals broader than the sepals, and labellum large and semi shaped, which is bright red or pale violet while the sepals and petals are white.

Arundina graminifolia (Don) Hochr. in Bull. N.Y. bot. Gard. 6:270, 1910; Holttum, 186, 1953; Hara, 425, 1966. *Bletia graminifolia* Don, Prodr. Fl. Nep. 29, 1825. *Limodorum graminifolia* Buch. Ham. ex D. Don, loc. cit. *Arundina bambusifolia* Lindl. Gen. et Spec. Orch. 125, 1831; F.B.I. 5:857, 1890; King & Pantl. 113, t. 156, 1898. *Cymbidium bambusifolium* Roxb. Fl. Ind. ed. 2, 3:460, 1832. (Fig. 1).

Flowers large, catleya-pink, sepals and petals *c.* 5.0 cm long, orbicular-obovate, apiculate; lip brighter red than the sepals, sidelobes short, midlobe small, bifid, crisped, disk with 3 lamellate nerves. Flowering time during late August to October, rarely in June or July. Collected from Nilkanth area, Suparitar, Pokhra, Phidim to Moktara, Pisapur (Kitamura), locality unknown (Herklotts).

Cephalanthera L. C. Rich.

Stem creeping, subterranean (rhizome), roots tuberous when the plant is leafless or they may be fiberous when the stem is leafy. Lower leaves lanceolate while the upper ones are linear. Flowers on a lax raceme, *c.* 1.5 cm long, white with yellow spots on the lip which has a short ridged epichile.

Cephalanthera ensifolia Rich. Orch. Annot. 29: 1817;Lindl. Gen. et Spec. Orch. 412, 1840; F.B.I. 6: 125, 1890; King & Pantl. 271, t. 362, 1898; Hara, 2nd. Rpt. 180, 1971.

Flowers white or lip spotted with yellow, sepals lanceolate, acute, petals elliptic, obtuse; ridges in lip, hypochile concave or saccate, embracing the column, epichile (midlobe) short, triangular, obtuse, 5-ridged, often marked with yellow spots. Flowering during April to

June. Collected from Pisang to Tatopani (Kitamura), Dhunche-Gossainkund (Hara).

Epipactis Sw.

Large terrestrial erect orchids with sessile leaves. Flowers in racemes, pendulous, bracts leafy. The lip is short, sessile on the base of the column. This orchid differs from *Cephalanthera* in structural details of the flowers which are rather large and showy.

Artificial key to the species of *Epipactis*

Flowers 2.5—3.75 cm in diam.; hypochile narrow..............*consimilis*

Flowers *c.* 2.5 cm in diam,; hypochile much broader than the epichile ....*royleana*

Epipactis consimilis Wall. ex Hook. f. in Fl. Brit. Ind. 6: 126, 1890; King & Pantl. 272, t. 364, 1898. Parker, Forr. Bull. bot. ser. 76: 8,1931.

Terrestrial with fiberous roots, leaves sessile, broadest lower ones while the upper ones narrow. Flowers orange-green, rarely spotted, drooping; sepals and petals pubescent; lip as long as the sepals, hypochile (sidelobes) narrow, oblong and turned upwards, epichile (midlobe) longer, lanceolate, inflexed at the base and then recurved. Flowering during February and March. Collected from West Nepal (Parker).

E. royleana Lindl. in Royle, Ill. Himal. 368, 1839, et Gen. et Spec. Orch. 461, 1840; F.B.I.6: 126, 1890.

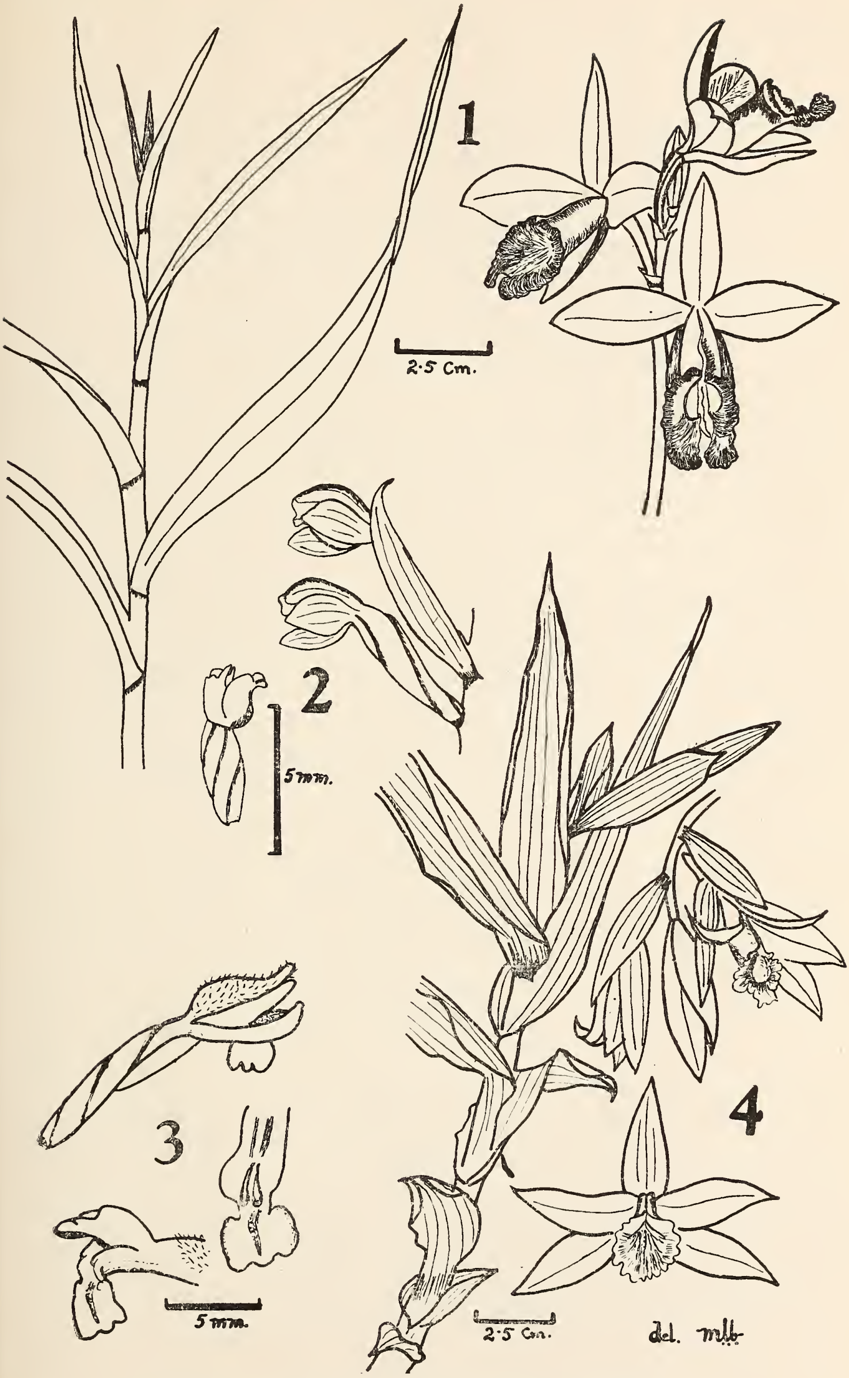
Flowers green with yellow lip which is longer than the sepals, sepals and petals nearly equal, glabrous. Hypochile of lip large, saccate and much broader than the ovate epichile. Collected from Thulo Gompha khola at 3100 m, authority Kitamura.

Goodyera R. Br.

The genus is named after an English botanist—J. Goodyer. These are known as 'rattle snake plantains', the name being given because of the mottlings on the foliage. These are also terrestrial leafy orchids with stem decumbent or creeping. Leaves are usually thick, petiolate and with a sheath. Flowers small on racemes, sepals often pubescent outside, dorsal sepal concave and along with the petals forming a hood over the column. Stigma is undivided.

Artificial key to the species of *Goodyera*

A. Stem stout, 45-60 cm tall, many leaved; spike dense flowered, bracts equalling the flowers ....*procera*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5 mm.
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del. mlb

Fig. 1. *Arundina graminifolia* (Don) Hochr.
Fig. 2. *Goodyera procera* Hk. f.
Fig. 3. *Herpysma longicaulis* Lindl.
Fig. 4. *Thunia alba* Reichb. f.

AA. Stem 10-20 cm tall, few leaved—

B. Lip smooth, channelled, lamellate within, with no hairs or soft setate .... *repens*

BB. Lip within setose and tubercled—
C. Leaves 3-5 nerved, never reticulate; bracts exceeding the flowers; fls. pink .... *foliosa*

CC. Leaves mottled with white—

D. Bracts exceeding the flowers, sepals with pink tips...... .... *hemsleyana*

DD. Bracts about equalling the flowers—
E. Leaves ovate-lanceolate, fleshy (thick) .... *vittata*

EE. Leaves cordate .... *cordata*

DDD. Bracts shorter than the flowers; fls. white........ *secundiflora*

Goodyera cordata (Lindl.) Bth. ex Hook. f. in Fl. Brit. Ind. 6:114, 1890; Holttum, 122, 1953; Hara, 2nd Rpt. 187, 1971. *Georchis cordata* Lindl. Gen. et Spec. Orch. 496, 1840.

Plants slender, *c.* 15-30 cm long; leaves ovate-cordate, basal sinus variable in depth, petiole slender, 6-12 mm long. Inflorescence a lax-flowered spike, flowers pubescent, bracts equalling or shorter than the flowers. Lip gibbous. Authority Hara.

According to Hara, the scape is shortly hairy, while the bracts are more densely hairy and the lip is also hairy on the lower half of inside.

G. foliosa (Lindl.) Bth. ex Hook. f. in Fl. Brit. Ind. 6:113, 1890; King & Pantl. 281, t. 374, 1898; Holttum, 121, 1953; Hara, 435, 1966. *Georchis foliosa* Lindl. Gen. et Spec. Orch. 496, 1840.

Bracts exceeding the flowers. Lip saccate, beak dilated, base setose within. According to Hara, the chief distinguishing characters are "blunt tipped papilla-like hairs on the bracts and scape". Authority Hara.

G. Hemsleyana King & Pantl. in Journ. Asiat. Soc. Beng. 64:342, 1895 et Ann. Roy. bot. Gard. Calcut. 8:281, 1898.

Plants 15-25 cm long; leaves 3 to 5 unequal, broadly ovate, acute; bracts lanceolate, exceeding the ovary. Flowers 1.5 cm long, white, sepals with long sparse hairs, tips pink, petals falcate. Lip with a sharp tooth on either side of the mouth of the saccate base, apical lobe oblong. Flowering time during July and early August. Extremely rare, only collected from Bagdoar at 2135 m.

G. procera Hk. f. Exot. Fl. 39, 1823; F.B.I. 6:111, 1890; King &

Pantl. 282, t. 278, 1898; Hara, 436, 1966. (Fig. 2).

Flowers minute, whitish, fragrant, sepals broadly ovate, obtuse, 1 nerved, petals spathulate; lip not longer than the column, base saccate, softly setose within, 2 large calli within the obtuse recurved tip. Occasional in the tropical region. Flowering during June. Collected from Eastern Nepal (Banerji).

G. repens (Linn.) R. Br. in Ait. Hort. Kew, ed. 2, 5:198, 1813; F.B.I. 6:111, 1890; King & Pantl. 282, t. 279, 1898; Hara, 436, 1966. *Satyrium repens* Linn. Sp. Pl. ed. 1, 945, 1753. *Goodyera marginata* Lindl. Gen. et Spec. Orch. 493, 1840.

Flowers whitish, lateral sepals ovate, acuminate, 1 nerved, dorsal sepal narrow, petals linear-falcate; lip ventricose, shortly beaked, channelled within, rostellar arms short. Flowering during July and August. Collected from Bagdoar, Taksindhu forest, Chandragiri.

G. secundiflora Lindl. in Journ. Linn. Soc. 1:182, 1857; F.B.I. 6:113, 1890; King & Pantl. 283, t. 376, 1898; Hara, 2nd. Rpt. 188, 1971.

Plants *c.* 15-30 cm long, covered with loose sheathing leaf-petioles. Leaves few, ovate-lanceolate, lamina base rounded, petiole stout and sheathing, dark green with silvery white veins. Inflorescence many flowered, *c.* 15 cm long, bracts shorter than the flowers. Lip saccate with setae within. Authority Hara.

G. vittata (Lindl.) Bth. ex Hook. f. in Fl. Brit. Ind. 6:113, 1890; King & Pantl. 280, t. 382, 1898; Hara, 437, 1966. *Georchis vittata* Lindl. in Journ. Linn. Soc. 1:184, 1857.

"This is determined only by the unicate sterile specimen with leaves silvery striated on the midrib and white reticulated at the apex of the blade"—authority Hara.

Herpysma Lindl.

Due to the creeping habit, the orchid is named as such. The leaves are membraneous with large hyline tubular sheaths. Flowers are dense on a short raceme, white but the sepals and petals have a pinkish tint. Lip is deflexed from the middle, apical lobe is blunt and broad, spur is as long as the ovary and parallel to it.

Herpysma longicaulis Lindl. Gen. et Spec. Orch. 506, 1840; F.B.I. 6:98, 1890; King & Pantl. 276, t. 367, 1898. (Fig. 3).

Flowers suberect, pale pink, sepals subequal, free, 5 nerved, dorsal sepal forming a hood with the petals, petals oblong, obtuse. Lip shorter than the sepals, subpanduriform, reflexed from the middle, adnate to the sides of the column, spreading, spur elongate and straight, tip bifid. Flowering during September to November. Collected from Bajrabarahi at *c.* 1370 m.

Listera R. Br.

The genus is named after an English physician—Martin Lister. These orchids are known as 'Tway blades' in the United States. These are rather insignificant terrestrial orchids with two leaves and fibrous roots. Flowers are small in racemes, with sepals and petals spreading; lip is pendulous from the base of the column.

Listera pinetorum Lindl. in Journ. Linn. Soc. 1:175, 1857; F.B.I. 6:104, 1890; King & Pantl. 256, t. 338, 1898; Kitamura, 104, 1955.

Terrestrial two leaved orchids. Inflorescence a few flowered raceme, flowers decurved, greenish-brown; sepals and petals subequal, free, spreading or reflexed, yellowish green. Lip cuneately broadly obcordate from a narrow base, deeply 2-lobed, twice or even thrice as long as the sepals, brownish, but deeper than the sepals. Collected from Thulo Gompha khola at 3500 m. Authority Kitamura.

Nervilia Comm. ex Gaud.

Perennial tuberous, coming into leaf after flowering. Tubers globose with small warty knobs. Leaf one, broadly cordate or orbicular. Sepals and petals subequal, spreading; lip adnate to the base of the column and embracing the same at its basal region, column broadened upwards. Schlecter and later Santapau & Kapadia consider *Nervilia* Comm. ex Gaud. as a distinct genus "primarily differing from *Pogonia* Juss. by the production of their flowers before the leaves and by having a separate stem which bears no leaves but may have scales or scaly sheaths".

ARTIFICIAL KEY TO THE SPECIES OF *Nervilia*

Flowers solitary, *c.* 2.5 cm long; sepals & petals white, anterior lobe of lip with 2 obscure sidelobes ....*macroglossa*

Flowers 7-15, *c.* 1.5 cm long; sepals & petals green, anterior lobe of lip undulate-crenate .... *scottii*

Nervilia macroglossa (Hk.f.) Schltr. in Engl. Bot. Jahrb. 45:402, 1911; Hara, 445, 1966. *Pogonia macroglossa* Hk. f. in Fl. Brit. Ind. 6: 120, 1890; King & Pantl. 267, t. 356, 1898.

Leaf reniform, petiole *c.* 7.5 cm long; flowering stalk bearing a single nodding flower, *c.* 2.5 cm long; sepals and petals subequal, linear-lanceolate. Lip gibbous, apical half expanded, with two obscure sidelobes near its base. Authority Hara.

N. scottii (Reichb. f.) Schltr. in Engl. Bot. Jahrb. 45:404, 1911. *Pogonia scottii* Reichb. f. Flora, 276, 1872; F.B.I. 6:120, 1890; King & Pantl. 269, t. 360, 1898.

Leaf ovate-reniform, petiole 10-20 cm long. Inflorescence a raceme of 7-15 flowers, flowers horizontal, sepals and petals connivent, linear-lanceolate, acuminate, dull green with red nerves. Lip 3 lobed to about the middle, subclawed, base saccate, yellowish-white with purple nerves, sidelobes obtuse, midlobe suborbicular, velvety. Flowering time April to May. Collected from Ranibari at 1370 m.

Spiranthes L. C. Rich.

Terrestrial leafy orchids with tuberous roots. Flowers are small in spirally twisted spikes, due to which the genus gets the name. Sepals more or less connate and with the petals forming a hood, the lateral sepals are gibbous at base, thus the spur is short or saccate. The bracts are longer than the ovary.

Spiranthes sinensis (Pers.) Ames, Orch. 2:55, 1908. *Neottia sinensis* Pers. Syn. Pl. 2:511, 1807.

Flowers small, pink or white crowded on a spiral spike; lateral sepals 3 mm long, obtuse, tips recurved, spreading, dorsal sepals combined with the petals to form a 3-lobed hood enclosing the column. Lip oblong, crisp, base saccate having 2 glands. Distributed widely at 1980 to 2285 m. Flowering during September to early November. Collected from Manichur, Chaubasa to Risingo, Nayapati to Risingo, Godavari, Gumurang to Sarti (Kitamura), Lokwa (Kitamura). King & Pantl. mention that the flowers produced in spring are white, while those appearing in autumn are often pink. Our observations do not support this seasonal change to effect the colour of the flowers. White flowered specimens are common in Godavari throughout the year except the cold months.

sub. sp. *australis* (R. Br.) Kitamura in Acta Phytotax. Geobot. 21:23, 1964, et Fl. Nep. Himâl. 451, 1966. *Spiranthes australis* (R.Br.) Lindl. Bot. Reg. t. 823, 1824 et Gen. et Spec. Orch. 464, 1840;F.B.I. 6:102, 1890.

Kitamura has separated this subspecies from the nominate race by the latter being glabrous on its inflorescence and ovary. The Himalayan species collected by Kitamura are all puberulous on the spikes and ovaries. Collected from Nagarkot by Kitamura.

Thunia Reichb. f.

The orchid is named in honour of Count von Thun Hohenstein of Bohemia. These are terrestrial with a tall and fleshy stem, leaves are numerous, membraneous and thin. The inflorescence is terminal, bracts persistent and pollen masses are in 4 pairs. The flowers turn brown or remain white on drying. This genus has been included under *Phajus* by many authors, but Reichenbach.f. distinguishes between *Thunia* and *Phajus*. Further, the genus *Phajus* is placed under subtribe Phajeae of Sympodiales-Pleuranthae (Kerosphaeroideae) according to the classification proposed by Schlecter.

Thunia alba Reichb.f. in Bot. Zeit. 764, 1825; F.B.I. 6:818, 1890. *Phajus albus* Lindl. in Wall. Cat. 3749 (n.n.) et Pl. Asiat. Rar. 2, t. 198, 1831. (Fig. 4).

Flowers large, 3-5, sepals and petals erecto-patent, white. Lip white or pale yellow with purple red nerves, shovel-shaped with a broad toothed, crisp midlobe, disk with 5 crested ridges, spur short. Flowering from late May to early July. Collected from Godavari, Dhunibesi, Dhaitarbesi, Baseri (Kitamura), locality unknown (Herklotts).

Zeuxine Lindl.

The name refers to the partial union of the lip and the column and possibly also to the growing together of the pollinia. These are also terrestrial herbs with membraneous leaves. Flowers are in spikes and the posterior sepal is concave and lies on the petals forming a hood. The genus can readily distinguished in the field by the character of the leaves and the stigmas being two.

ARTIFICIAL KEY TO THE SPECIES OF *Zeuxine*

A. Leaves sessile, linear-lanceolate; scape dense flowered; apical lobe of lip suborbicular .... *strateumatica*

AA. Leaves shortly petioled; scape lax-flowered —

B. Apical lobe of lip very small; bracts equalling the ovaries; leaves with a median stripe .... *goodyeroides*

BB. Apical lobe of lip 2-lobulate; bracts exceeding the ovaries; leaf sheath inflated, hyaline .... *flava*

Zeuxine flava (Lindl.) Benth. in Benth. & Hook.f. Gen. Pl. 3:600, 1883; F.B.I. 6:108, 1890; King & Pantl. 289, t. 386, 1898; Hara, 452, 1966. *Etaeria flava* Lindl. in Wall. Cat. 7380 (nomen nud.).

Scape lax flowered, bracts exceeding the ovaries, flowers small, white with a pink lip, sepals obtuse; lip shorter than the sepals terminal lobe of lip 2 winged, wings broadly obovate or hatchet-shaped, sac with 2 long spurs. Flowering during April and May. Collected from Banepa to Dolaghat at *c.* 1220 m.

Z. goodyeroides Lindl. Gen. et Spec. Orch. 486, 1840; F.B.I. 6:107, 1890; King & Pantl. 287, t. 383, 1898.

Scape lax flowered, bracts reddish, equalling the ovaries; flowers pinkish, sepals ovate, acute, lateral sepals lanceolate, 1 nerved, petals falcate, very obtuse. Lip slightly exceeding the sepals, cymbiform, terminal lobe orbicular, apex subtruncate, rolled inwards along the margins, membraneous. Flowering during April and May. Collected from Dolaghat to Chaubas at *c.* 1830 m. Probably this species is rare as it has been collected only once.

Z. strateumatica (Linn.) Schltr. Orch. Deutch. N. Giun. 77, 1911. Holttum, 131, 1955. *Orchis strateumatica* Linn. Sp. Pl. 943, 1753. *Zeuxine sulcata* Lindl. Gen. et Spec. Orch. 485, 1840; F.B.I. 6:106, 1890; King & Pantl. 286, t. 381, 1898.

Scape dense flowered, bracts much longer than the ovaries; flowers small, white or light yellow, sepals 3 mm long, oblong, membranous, petals oblong, obtuse. Lip yellow, equalling the sepals, cymbiform, contracted into short pubescent claw, bearing a terminal lobe or 2 small lobes. Flowering probably during December. Collected from the banks of Trisuli Khola area. (also Burkill).

(*to be continued*)

P.S. After going to the press, we have noticed Balakrishna has described a new species—*Listera nepalensis* (Blumea, *14*(1): 287-290, 1966).

A Catalogue of the Birds in the Collection of the Bombay Natural History Society—15

Upupidae and Bucerotidae

BY

HUMAYUN ABDULALI

[*Continued from Vol.* **70**(1): 155]

This part deals with 175 specimens of 16 species and subspecies up to No. 776 in IND. HANDBOOK (**4**:143) and No. 23744 of the Society's register. Mr. S. A. Hussain, Research Assistant, assisted with measurements.

763 **Upupa epops epops** Linnaeus (Sweden), European Hoopoe **4** : 308

16 : 6♂♂ 9♀♀ 1 o?

1 *Siyahad, Arabia;* 1 *Baghdad,* 1 *Shaiba, Iraq;* 1 *Raixe Besk,* 2 *Shiraz, Iran;* 1 Teghat, Kalat, Baluchistan, 1 Chitral; 2 Ambala, Punjab; 1 Kotri, Sind; 1 Pali, Jodhpur, Rajasthan; 1 Amreli, 1 Ajwa, Baroda, Gujerat; 1 Nawacot, Nepal, 1 Dibrugarh, Assam.

As is evident from the literature available, the races of the Hoopoe cannot be easily separated and the difficulties are increased by two, or even perhaps three, races being found at the same place during winter and on migration.

The present series covers birds with the palest heads, in all of which the white subterminal patches to the rear feathers of the crest are distinct. None have an all-black first primary.

The measurements are under No. 766.

764 **Upupa epops saturata** Lonnberg (Kjachta, Southern Transbaicalia) Tibetan Hoopoe **4**: 310

54 : 25♂♂ 23♀♀ 6 o?

1 *Meshed,* 1 *Chahrbar, Persian Gulf;* 2 Mastung, Baluchistan; 1 Peshawar, 1 Chitral; 1 Kashmir; 4 Ambala, 1 Ladhwa; 1 Keonthal State, 3 Simla; 2 Delhi; 1 Bharatpur, 1 Haroonabad, Bahawalpur; 1 Bhong, Indus River; 4 Karirohar, 1 Devisar Tank, 1 Chobassi, Kutch; 1 Nadiad, Kaira District, Gujerat; 1 Santanpara, Gwalior; 4 Kalyan, 1 Juhu, 2 Andheri, Salsette, Bombay, 2 Panvel, Kolaba, Maharashtra; 1 Mavli,

1 North Kanara; 1 Dantwara, 1 Geedam, Bastar; 1 Almora, 1 Bulandshahr, U.P.; 1 Nawacot, Nepal; 1 Banhar, Bihar; 1 Manaktala, Calcutta; 1 North Cachar, 1 Dibrugarh, Assam; 1 Abor 1 *Upper Burma;* 3 *Temple of Heaven, Peking, China.*

There is considerable variation in the colour of the underparts and the head and crest is darker than in nominate *epops,* most males lacking the pink on the breast and the females being duller and some having a greyish-brown tinge. Both types of females occur in the same areas at the same time and I have been unable to determine if the latter represents a first-year plumage of the same race or the female of another. They show no difference in size, and for the moment, I am listing them as first-year females.

Only 2 ♂ (Nos. 18879 and 18889) from Simla 6700′ (21 August) and Keonthal State (3 July) appear similar to first-year females referred to above.

2 ♂♂ (Nos. 18876 and 18887) from Delhi (29 March) and Ambala (23 February) differ from the others in having the small first primary all-black. The former has an exceptionally long (74 mm) bill and the latter, which barely shows any other colour difference is marked "juv." by the collector, but a sketch of the testes on the obverse of the label measures 4 × 3 mm.

Some of the specimens referred to above are marked *U. e. epops* by earlier workers.

The popular name Tibetan Hoopoe appears to be a strange name for a bird whose type locality is apparently far away in Transbaicalia.

The measurements are under No. 766.

765 **Upupa epops ceylonensis** Reichenbach (Ceylon) Ceylon Hoopoe

4 : 311/2

15 : 5 ♂♂ (1* pull.) 8 ♀♀ 20?

2 Bharatpur; 1 Delhi; 2 Chikalda, Berar; 3 Kanyakumari; 1 Gingee, South Arcot; 1 Nellore, 1 Anantgiri, Vizagapatam, A.P.; 1 Bhusandpur, Chilka Lake, Orissa; 1 Baghowni, Darbhanga, 1 Muzaffarpur, Bihar; 1 Meerut, U.P.

These can be separated from the others by the darker rufous heads and crests. The white subterminal tips to the black ends of the hindmost crest feathers are either absent or greatly reduced. They are also smaller, and in 8 individuals of both sexes, the first primary is all-black. The series includes specimens obtained in April (2), May (1), July (1), August (1) and September (2) which were almost certainly resident in the areas where collected.

The measurements are under No. 766.

766 **Upupa epops longirostris** Jerdon (Burma) Burmese Hoopoe

4 : 312

1 ♀ No. 11494, *Thayetmyo, Burma.*

This bird is separated only on a geographical basis. It resembles others under *ceylonensis* in their darker colour, absence of white subterminal tip to the hinder crest feathers and an all-black first primary. Incidentally, Jerdon when describing this said that the main difference from *ceylonensis* was the white spot on the first primary, which was all-black in *ceylonensis*. The 7 specimens of *ceylonensis* in which the first primary is spotted include one taken on 27 July at Gingee, South Arcot, which was no doubt resident in the area.

Wing	Bill	Tarsus	Tail
U. e. epops			
♂♂ 147-151 av. 148	52-57 av. 55	21-23	95-104 av. 101
(Witherby 140-153	from skull 53-63	22-24	98-109)
♀♀ 136-150 av. 145	47-54 av. 48.6	21-23	95-100 av. 97
(Witherby 136-148	50-58	—	—)
U. e. saturata			
20 ♂♂ 141-154 av. 146	42-60 av.51	21-24	86-104 av. 99
23 ♀♀ 126-154 av. 142.6	44-53 av. 50	21-24	89-107 av. 95
♂♀ 123*-164	39-55	—	—)
U. e. ceylonensis			
4 ♂♂ 130, 135,140(2)	(42),54(2),55	20-22	94,96,99,100
8 ♀♀ 120-132 av. 126.8	42-48 av. 45	20-22	87-102 av. 92
(IH ♂♀ 120-143**	from skull 51-63	20-22	83-99)
U. e. longirostris			
♀ 125	50	22	90
(136-158	42-66 mostly over 50	—	—)

* Ticehurst (JBNHS 34 : 427) said this was in error and all were over 140.
** "mostly under 135".

767 **Tockus birostris** (Scopoli) (Coromandel, India) Grey Hornbill **4** : 301

20 : 5 ♂♂ (1 juv.) 13 ♀♀ 2 o ?

1 Kalka, 1 Jagadhri, 1 Ambala, Punjab; 2 Delhi; 1 Kathiawar; 1 Nandur, Niphad, Nasik; 1 Chitteri Range, Salem Dist.; 2 Hoshangabad, 2 Barkot, Bamra, 1 Central Provinces; 1 Besai, Mayurbhanj, 1 Singbhum, Orissa; 1 Hazaria, Patharghatta, 2 Baghowni, Tirhut, Bihar; 1 Meerut, U.P.; 1 Bankulwa Morang, Nepal.

Wing	Bill	Tarsus	Tail
♂♂ 213,215,224,225	101,105,106,110	40,42,45(2)	270,278,280
5 ad. ♀♀ 204-216 av. 207	84-101 av. 91	41-46 av. 43	220-268 av. 248
6 juv. ♀♀ 192-215 av. 208	72-107 av. 86	36-45 av. 43	237-268 av. 247
(IH ♂♀ 196-228	81-105	42-46	237-297)

The material available does not support the suggestion that northern birds are less brown and more grey than those from the south.

Fresh specimens are greyer than old ones. Four males and five females have the tips of the primaries white, and are presumably adult, but such females do not have their wings any longer than the eight specimens without the white.

768 **Tockus griseus griseus** (Latham) (New Holland = Malabar) Malabar Grey Hornbill 4 : 303

8 : 5 ♂♂ (2 subadult or 1st year) 3 ♀♀ (2*pull.)

2* Khandala, Poona; 1 Govadsagar, 1 Morda, Goa Frontier; 1 Santgal, N. Kanara, 2 Sagar, Sorab, Mysore; 1 Palni Foothills.

	Wing	Bill	Tarsus	Tail
3 ♂♂	205, 208, 210	95,107,110	42,43,45	226(2),232
2 ♂♂ subad	190, 204	80,96	40,45	195
1 ad ♀	197	73	40	198
(♂♀	205-220	100-110	44-45	219-235)

(IH wing 3 ♂♂ 205-218; 9 ♀♀ 185-195)

In addition to the characters mentioned in IND. HANDBOOK (4: 132) first year males have small grey tips at the end of the white on the outer primaries, which are all white in the adults (as in *birostris*).

The single adult female from Palni Foothills is darker on the underparts than the males. The pullets, both taken from nests and reared in captivity for some time, have rufous edges to all the visible wing feathers and coverts *contra* whitish in the first-year birds.

769 **Tockus griseus gingalensis** (Shaw) (Ceylon) Ceylon Grey Hornbill 4 : 304

1 ♂ Ceylon. Wing 201; bill 89; tarsus 37; tail 216.

Unlike Indian birds, the single specimen has a dark bill with "a long sharply defined white patch on the lower portion of upper mandible" tapering to a point some distance before the tip, which pattern is presumably characteristic of the female (IND. HANDBOOK 4:133).

770 **Ptilolaemus tickelli austeni** (Jerdon) (Asalu, Cachar Hills) Assam Brownbacked Hornbill 4: 298

2 o ? (1 juv.*) North Cachar, Assam.
Wing 297*,320; bill 107*,136; tarsus 43*,48; tail 247*,272.
Both specimens are fragmentary.

771 **Aceros nipalensis** (Hodgson) (Nepal) Rufousnecked Hornbill 4 : 294

2:1* ♂ (head only) 1 o ?

1* Sangur, Darjeeling; 1 Aijal, Lushai Hills, Assam.

772 **Rhyticeros undulatus ticehursti** Deignan (Huai Oi, 14 km. north of the Ban Pak Li, Nan Province, Thailand) Assam Wreathed Hornbill 4 : 291 (part)

3:3 ♂♂ (by plumage; 1* head only).
1 Aijal, Lushai Hills, 1* Dafla Hills, Assam; 1 no date.
♂♂ Wing 469, 505; bill 230, 245; tarsus 64, 66; tail 322.
♀ * Wing 450; bill 202; tarsus 67; tail 306.

The female* which is all black except for the white tail was borrowed from Bengal Natural History Society at Darjeeling.

The head* presumably of a young male, has only traces of corrugations at the side and at the top of the bill. The rich rufous on the head is already present.

773 **Rhyticeros (undulatus) narcondami** (Hume) (Narcondam Island) Narcondam Hornbill **4**:293

6:3 ♂♂ 3 ♀♀ Narcondam Island.

In IND. HANDBOOK **4**:137, the wing is required to be under 130 mm. This is doubtless in error, as also "100-199" for female bills, from skull, on p. 139.

EL **Rhyticeros plicata subruficollis** (Blyth) (Tenasserim)

5 ♀♀ (4 by plumage; 1* juv. with no corrugations on top of bill).
1 *Pegu;* 1 *Ataran,* 1 *Amherst;* 1 *Mergui;* 1* no data (J. P. Cook).

Wing	Bill	Tarsus	Tail
406, 430(2), 432	171, 180, 196(2)	52,54(2), 58	230, 253, 254
(420-445	196-205	55-59	252-270)

The adult birds show wavy lines corresponding to corrugations at the base of the upper and lower mandibles, and are otherwise exact miniatures of *R. undulatus ticehursti. Narcondami* are still smaller and, without access to specimens of nominate *plicata,* it would appear that *all three are of the same species.*

774 **Anthracoceros malabaricus malabaricus** (Gmelin) (Chandernagore) Indian Pied Hornbill **4**: 288

10 : 6 ♂♂ (1 juv.) 3 ♀♀ 1 o ?

1 Kalisar, Jagadhri, Punjab; 1* Berbera, Puri Dt., Orissa; 4 Hazaria, Patharghatta, Bihar; 1 Lenda Ghali, Nepal; 1 Bagho Bahar, Cachar, 1 Rangti, Lushai Hills, Assam; 1 Baronghola (col. J. A. 1876 = Barangoli, Dacca?).

Wing	Bill	Tarsus	Tail
♂♂ 295-316 av. 306	158-164 av. 162	57-62 av. 59	276-291 av. 285
(IH 249-315, once 336	159-170	60-68	259-318)
♀♀ 290, 291, 305 *	134,140*,141	48,52*,54	267,275,290*
(IH 280-301	136-146	*c.* 60	259-290)

Sp. No. 18867 from Berbera is marked female, but has the bill marked with a small black patch on the upper mandible and front lower end of casque, as in the male, and the measurements are also closer to that sex.

In this species, the black central tail feathers are slightly longer than the others but do not appear to project as far out as in *coronatus.*

The Lushai Hills would appear to be within the range of *A. m. leucogaster,* but as the single specimen is a juvenile, it is not possible to determine its adult size.

EL **Anthracoceros malabaricus leucogaster** (Blyth) (Tenasserim) Burmese Pied Hornbill

10 : 5♂♂ 5 ♀♀ (1 head only)

1 *Kawya,* 1 *Singhaling Hkanti,* 1 *Sainnaing, E. Bank, Chindwin River,* 1 *Kani, Lower Chindwin;* 1 *Maymyo,* 1 *Kama, Theyetmyo,* 2 *Ngaphaw, Prome Dist.,* 1 *Sandoway,* 1 *Ataran, Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	270-292 av. 281.5	141-153 av. 148.5	56-58	240-272 av. 253
	(262-290	98-135	—♂♀	225-266 one 290)
♀♀	237, 254,265,276	127(2),138,151	47(2), 48,49	213,228,242,248
	(245-286	92-122	—	—)

775 **Anthrococeros coronatus coronatus** (Boddaert) (Malabar) Malabar Pied Hornbill **4**:286

10 : 5 ♂♂ 5 ♀♀

1 Kansardey, 1 Fanasgaum (= Phanasgaum, Deogad), 1 Khawar, 2 Ratnagiri; 1 Supa Patha, N. Kanara; 1* Supkhar, Balaghat, 1* Chota Dongar, 1 Orcha, Bastar; 1 Demiria, Bund, Orissa.

The two specimens from Kansardey and Fanasgaum were collected by "J. A." on 21 March 1875 and 16 March 1878. Several other birds obtained by Dr./Mr. Amstrong in 1878 are from Ratnagiri, and it may be assumed these were obtained by the same person in the same district. Sp. 11414 collected by G. Vidal at Ratnagiri in 1878 is in tatters, literally tied together with string! The bill has the shape and the large patch of black on the casque as in *coronatus,* but the tail feathers are tipped white as in *malabaricus* and is so marked by Sálim Ali. In view however of the possibility of the tail belonging to another specimen, I am not extending the accepted range of *malabaricus* but leaving this in *coronatus!*

	Wing	Bill	Tarsus	Tail
♂♂	326-335 av. 331	210-223	61-64 av. 62	270-337 av. 308
	(IH 315-342	216-227	*c.* 65	295-335)
♀♀	297-305 av. 300	142*,152*,175 185,195	52-65 av. 57.5	245,291,295,296
	(IH 295-328	from gape 126-166	*c.* 61	—)

The bills have been measured from the posterior of the casque. The two females marked * have short casques without the pointed front and also traces of black on the white outer tail feathers—on outer basal portion in one, and on basal half of shaft in the other.

In IND. HANDBOOK the bills of the males and females are measured in separate ways.

776 **Buceros bicornis homrai** Hodgson (Nepal) Great Pied Hornbill 4 :284

12 : 3 ♀ ♀ 9 o ? [4 ad., 3 juv. (1 head only), 2 chicks]
1 Paladhur, Mahad Tal., Kolaba Dist.; 1 Ratnagiri, 2 Goa Ghats; 1 Honavar, 1 Karwar, N. Kanara; 1 Sumasheri, Nepal; 1 Eastern Bhutan, 1 *Ataran, Burma;* 3 no data.

An adult female (Goa Ghats) and an immature bird with no data show a large amount of brown on the neck. Various stages of the growth of the bill are represented, but the absence of data regarding sex etc. prevents any observations.

(*to be continued*)

A new species of *Themeda* Forsk. from India[1]

BY

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(*With a plate*)

According to Bor, (1960), GRASSES OF BURMA, CEYLON, INDIA AND PAKISTAN, eighteen species of the genus *Themeda* are found in India, the rest being distributed in Australia, Ceylon, Burma, Pakistan, Java, China, Indo-China, Indonesia and South Africa. A new species of *Themeda* has been recently found in India and is described below.

Themeda dacruzii sp. nov. (Figs 1-5).

Themeda anatherae (Nees) Hack. Similis sed differt spiculis involucralis glabris, 8 mm longis et Pedunculis 17-20 mm longis.

Allied to *Themeda anathera* (Nees) Hack. but differs with regard to the glabrous involucral spikelets, which are 8 mm long and the peduncles which are 17-20 mm in length.

A perennial grass; culms up to 120 to 130 cm, very slender, completely glabrous and smooth, polished geniculately ascending, branching at every node, branches erect; nodes-tumid and pruinose; internodes solid, glabrous, polished and completely round; leaf blade 35-40 cm long, 0.4-0.6 cm wide, leaves linear acuminate, ciliated at the base; ligule membranous or chartaceous, 0.2 cm long; sheath compressed, smooth, glabrous and clasping on the culm halfway.

Panicle elongate, very narrow, occupying about half the culm with sparse racemes of spikelets issuing from the spatheole which turns brownish at maturity; racemes consisting of the usual four homogamous involucral spikelets surrounding a sessile and pedicelled spikelet. The involucral spikelets are in pairs and situated at different level, involucral spikelets completely glabrous; peduncle 1.7 to 2.0 cm long, capillary; raceme 1.6 to 2.0 cm long, oblong, imbricate, glabrous, green, brownish, joints between the hermaphrodite spikelets 0.15 to 0.20 cm long.

Involucral spikelets 6-8 mm long, lower glume scabrous above, 7-9 nerved, upper glume boat shaped papery and 1 nerved, 6-8 mm

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[1] Accepted November 13, 1971.

Birari: *Themeda dacruzii*

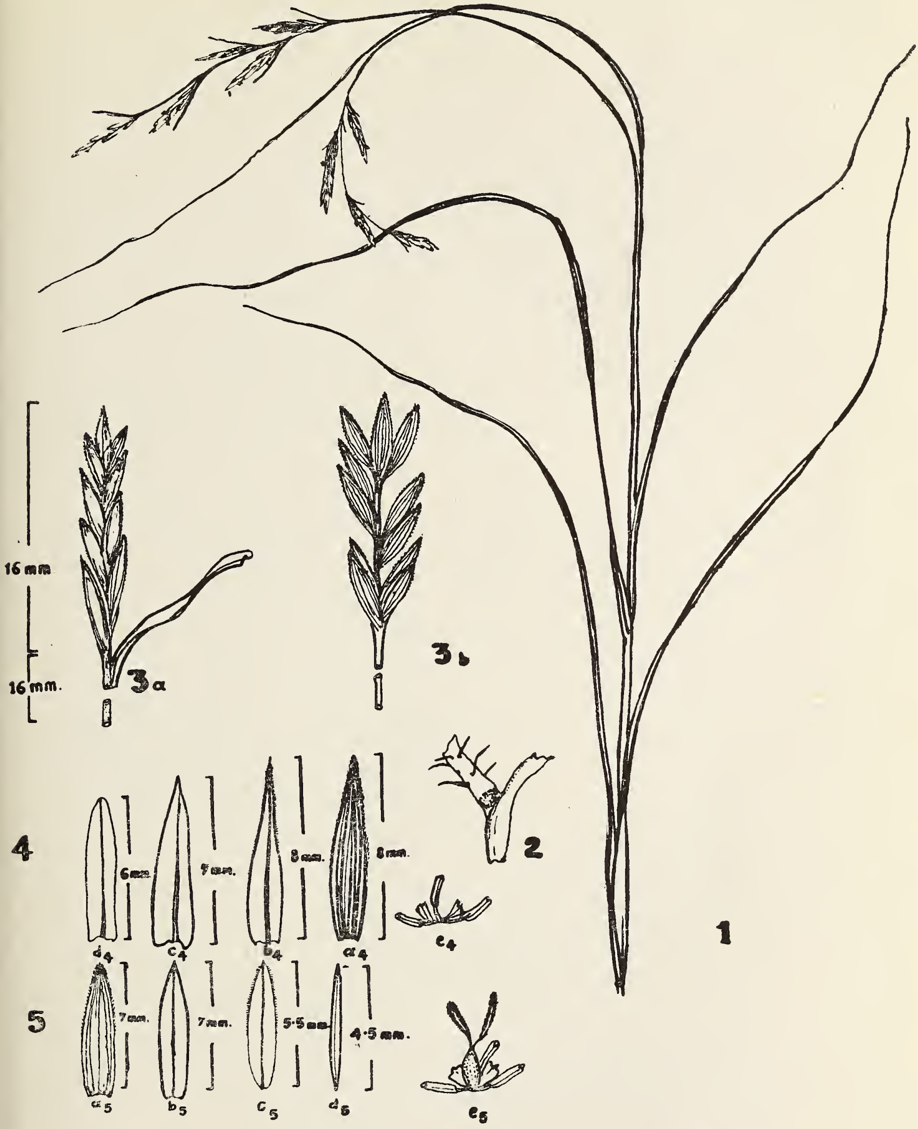
16 mm
16 mm.
3a
3b
1
2
4
6mm.
7mm.
8mm.
8mm.
d4
c4
b4
a4
e4
5
7mm.
7mm.
5·5mm
4·5mm.
a5
b5
c5
d5
e5

Fig. No. 1-5—*Themeda dacruzii* sp. nov.

1) A drawing of a herbarium specimen.
2) Culm showing the papery ligule and small hairs at the base of sheath.
3) a. Showing the length of the raceme and pendunce.
3) b. A raceme showing the involucral and inner spikelets.
4) a_4, b_4, c_4, d_4, showing the glumes of involucral spikelet.
e_4 their anthers with two lodicules.
5) Fig. a_5, b_5, c_5, d_5, glumes of the bisexual spikelets.
e_5, shows the bifid stigmatic ovary with three anthers and two lodicules.

long; lemma-hyaline and 7 mm long while palea 6 mm long; sessile spikelet 6.5 to 7 mm long, linear, lanceolate; lower glume, acute, entire, ciliated on the keel, distinct 7 nerved, 7 mm long; upper glume lanceolate, acute, one nerved, smooth on the keel, margins hyaline, 7 mm long. Upper floret bisexual, lemma lanceolate and ciliated on the upper half and 5.5 mm long; palea very narrow, chartaceous, 4.5 mm long; pedicelled spikelets are as involucral spikelets. Stamens 3, anthers 2.5 mm long; pistil usually one and sometimes two in the hermaphrodite spikelet. Stigma plumose, bifid; ovary superior; lodicules two (Figs. 1-5).

Holotype collected on Mussoorie hill, 20 km from Dehra Dun, U.P., India by the author on 17th December 1969 under the field No. I-774 and deposited in the Herbarium of Professor of Agricultural Botany and Specialist to Mahatma Phule Krishi Vidyapeeth, College of Agriculture, Poona-5. Two isotypes bearing the same number have been deposited in Herbarium of the Botanical Survey of India, Western Circle, Poona.

Etymology:

The species is named after Professor Rui D'Cruz, under whose guidance, this work was carried out.

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Systematics of Molluscan wood borers recorded from India[1]

BY

L. N. SANTHAKUMARAN[2]

INTRODUCTION

Molluscan wood borers, because of the damage they cause to marine wood construction, have attracted active attention of scientists in most countries. In India appreciable work has been done on this group of pests under the scheme for "Protection of Timber against marine organisms' attack" sponsored by the Wood Preservation Branch of the Forest Research Institute and Colleges, Dehra Dun, and also by other workers. As a result of this about 57 species of *Teredinidae* and 4 species of *Pholadidae* have been recorded from various parts of the Indian coast, and out of the above *Teredinidae,* 20 have been described as new to science.

Turner (1959), while reviewing the problems inherent in the study of the *Teredinidae,* emphasised the need for a catalogue of the family and stated that "there are far more names available than there are good species". In a very valuable recent contribution, Turner (1966) has carefully examined the type specimens of all the species described under the *Teredinidae* and has suggested a new classification of the family that has resulted in reducing the number of valid species from over 600 to about 65. The reasons given by Turner for this drastic rearrangement are as follows:

1. Many species have been described on the basis of shells only or upon a few dried specimens or on a single specimen and sometimes on a fragment of a pallet.
2. A number of new species have been introduced on the basis of zoogeographic provinces little knowing that the Teredinids are readily distributed by drift-wood and ships.
3. As the literature on the systematics of this group is scattered and no illustrated work covering the whole family available, different workers engaged in the study of local faunas created numerous synonyms.
4. All the subgenera have been scrapped in the new classification, as in most cases there are transitional species between them.

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5. Most of the work on shipworms has been done on the restricted basis of either a limited geographic area or a museum collection. Hence "the percentage of synonyms created has been directly proportional to the narrowness of outlook".

The new classification of the *Teredinidae,* proposed by Turner, thus appears justified and acceptable. Under this arrangement quite a number of Teredinids described from India are reduced to synonyms. In order to avoid confusion in future references to these "species" an attempt is made in this paper to arrange all the species recorded from India under Turner's new classification. The genera and species are arranged in alphabetical order and under each species the localities from which it is recorded are given and against each locality the synonyms by which it was reported together with the name of the author and the year of publication.

Systematics and Distributional Records

PHYLUM	MOLLUSCA
CLASS	PELECYPODA
ORDER	EULAMELLIBRANCHIATA
FAMILY	TEREDINIDAE
SUBFAMILY	TEREDININAE

Genus *BACTRONOPHORUS* Tapparone Canefri

1. **Bactronophorus thoracites** (Gould)

Bombay	*Teredo* (*Bactronophorus*) *thoracites* Gould (Palekar & Bal 1957; Palekar, Santhakumaran & Bal 1964).
Sunderbans (West Bengal)	*Teredo* (*Bactronophorus*) *thoracites* Gould (Roonwal 1954, 1966).
Visakhapatnam	*T.* (*Bactronophorus*) *thoracites* Gould (Nagabhushanam 1955).

Genus *DICYATHIFER* Iredale

2. **Dicyathifer manni** (Wright)

Bombay	*Teredo* (*Kuphus*) *manni* (Wright) (Palekar, Santhakumaran & Bal 1964).
Cochin	*Teredo manni* (Nair 1964), *Teredo* (*Kuphus*) *manni* Wright (Saraswati 1964).
Karwar	*T.* (*Kuphus*) *manni* (Wright) (Palekar & Bal 1957 a).

Madras	*T.* (*Kuphus*) *manni* (Wright) (Daniel 1958). *T. manni* (Nair 1964).
Pulicat lake (Tamil Nadu)	*T.* (*Kuphus*) *manni* (Wright) (Nair 1963).
Sunderbans (West Bengal)	*T.* (*Kuphus*) *manni* (Wright) (Roonwal 1966).
Visakhapatnam	*T.* (*Teredothyra*) *manni* Wright (Nagabhushanam 1955).

Genus *LYRODUS* Gould

3. **Lyrodus affinis** (Deshayes)

Visakhapatnam	*Teredo* (*Lyrodus*) *milleri* Dall, Bartsch & Rehder (Nagabhushanam 1960).

4. **Lyrodus pedicellatus** (Quatrefages)

Bombay	*T.* (*Lyrodus*) *malaccana* Roch, *T.* (*Lyrodus*) *pedicellata* Quatrefages (Palekar, Santhakumaran & Bal 1964).
Cochin	*T.* (*Teredops*) *diegensis* Bartsch, *T.* (*Teredops*) *samoaensis* Miller (Erlanson 1936). *T. malaccana* (Nair 1964), *Teredo* (*Lyrodus*) *malaccana* Roch (Saraswati 1964).
Kayamkulam (Kerala State)	*T.* (*Teredo*) *madrasensis* Nair (Nair 1954).
Madras	*T.* (*Teredo*) *madrasensis* Nair, *T.* (*Teredo*) *indica* Nair (Nair 1956). *T. singaporeana* Roch (Nair 1964).
Mylapore, Madras	*T.* (*Teredo*) *madrasensis* Nair (Nair 1954).
Pamban, Rameswaram (Tamil Nadu)	*T.* (*Teredo*) *madrasensis* Nair, *T.* (*Lyrodus*) *malaccana* Roch (Nair 1962).
Tondi (Tamil Nadu)	*T.* (*Teredo*) *indica* Nair, *T.* (*Teredo*) *madrasensis* Nair (Nair & Gurumani 1957a).
Adirampatnam (Tamil Nadu)	*T.* (*Teredo*) *madrasensis* Nair (Nair & Gurumani 1957a).

Visakhapatnam	*T.* (*Teredops*) *diegensis* Bartsch, *T.* (*Teredops*) *samoaensis* Miller (Nagabhushanam 1955). *T.* (*Coeloteredo*) *singaporeana* Roch, *T.* (*Lyrodus*) *malaccana* Roch (Nagabhushanam 1960).

Genus *TEREDO* Linnaeus

5. **Teredo bartschi** Clapp

Visakhapatnam	*T.* (*Teredo*) *bartschi* Clapp (Nagabhushanam 1955).

6. **Teredo clappi** Bartsch

Bombay	*T. clappi* Bartsch (Santhakumaran 1966).
Cochin	*T. renschi* (Nair 1964), *Teredo* (*Coeloteredo*) *renschi* Roch (Saraswati 1964).
Godavary estuary, near Yanam	*T.* (*Zopoteredo*) *trulliformis* Miller (Ganapati & Rao 1959).
Madras	*T.* (*Teredo*) *renschi* Roch (Daniel 1958).
Visakhapatnam	*T.* (*Zopoteredo*) *trulliformis* Miller (Nagabhushanam 1955).

7. **Teredo furcifera** Von Martens

Bombay	*T.* (*Teredo*) *parksi* Bartsch (Palekar, Santhakumaran & Bal 1964).
Cochin	*T. furcifera* (Nair 1964), *Teredo* (*Teredo*) *furcifera* Martens (Saraswati 1964).
Godavary estuary, near Yanam	*T.* (*Teredo*) *furcillatus* Miller (Ganapati & Rao 1959).
Kayamkulam (Kerala State)	*T.* (*Teredo*) *furcillatus* Miller (Nair 1955).
Madras	*T.* (*Teredo*) *parksi madrasensis* Nair (Nair 1955). *T.* (*Teredo*) *furcifera* Martens, *T.* (*Teredo*) *parksi* Bartsch, *T.* (*Teredo*) *furcillatus* Miller (Nair 1956). *T.* (*Teredo*) *furcifera* Martens (Daniel 1958).

Pulicat lake (Tamil Nadu)	*T.* (*Teredo*) *australasiatica* Roch (Nair 1963).
Tondi (Tamil Nadu)	*T.* (*Teredo*) *parksi* Bartsch (Nair & Gurumani 1957a).
Visakhapatnam	*T.* (*Teredo*) *parksi* Bartsch, *T.* (*Teredo*) *furcillatus* Miller (Nagabhushanam 1955). *T.* (*Teredo*) *bensoni* Edmondson (Nagabhushanam 1960).

8. **Teredo fulleri** Clapp

Pamban, Rameswaram (Tamil Nadu)	*T.* (*Teredothyra*) *indomalaica* Roch (Nair 1962).

9. **Teredo triangularis** Edmondson

Visakhapatnam	*T.* (*Zopoteredo*) *triangularis* Edmondson (Nagabhushanam 1960).

Genus *TEREDORA* Bartsch

10. **Teredora princesae** (Sivickis)

Cochin	*Teredo* (*Dactyloteredo*) *diederichseni* Roch (Saraswati 1964). *T. diederichseni* (Nair 1964).
Madras	*T.* (*Teredora*) *gregoryi* Dall, Bartsch & Rehder (Nair 1954, 1956). *T.* (*Teredora*) *minori* Nair (Nair 1955), *T.* (*Dactyloteredo*) *diederichseni* Roch (Daniel 1958).
Pamban, Rameswaram (Tamil Nadu)	*T.* (*Dactyloteredo*) *diederichseni* Roch (Nair 1962).

Genus *TEREDOTHYRA* Bartsch

11. **Teredothyra excavata** (Jeffreys)

Royapuram, Madras	*T.* (*Teredothyra*) *liniaris* Nair (Nair 1955).

12. **Teredothyra smithi** (Bartsch)

Madras	*T.* (*Zopoteredo*) *bengalensis* Nair (Nair 1954).
Pamban, Rameswaram (Tamil Nadu)	*T.* (*Nototeredo*) *nambudalaiensis* Nair & Gurumani (Nair 1962).

Ramnad (Tamil Nadu)	*T.* (*Nototeredo*) *nambudalaiensis* Nair & Gurumani (Nair & Gurumani 1957).
Tondi (Tamil Nadu)	*T.* (*Zopoteredo*) *bengalensis* Nair (Nair & Gurumani 1957a).

Genus *UPEROTUS* Guettard

13. **Uperotus clavus** (Gmelin)

Madras	*Teredo clava* Gmelin (Gravely 1941). *T.* (*Uperotus*) *clava* Gmelin, *T.* (*Teredora*) *rehderi* Nair (Nair 1954). *T.* (*Teredora*) *rehderi* Nair (Nair 1956). *T.* (*Uperotus*) *clava* Gmelin (Daniel 1958).
Ramnad (Tamil Nadu)	*T.* (*Teredora*) *vattanansis* Nair and Gurumani (Nair & Gurumani 1957b).

Subfamily BANKINAE

Genus *BANKIA* Gray

14. **Bankia bipalmulata** (Lamarck)

Kovilam (20 miles South of Madras)	*B.* (*Bankia*) *bipalmulata* (Lamarck) (Nair 1954).
Madras	*B.* (*Bankia*) *bipalmulata* (Lamarck) (Nair 1954; Daniel 1958).
Pamban, Rameswaram (Tamil Nadu)	*B.* (*Bankia*) *bipalmulata* (Lamarck) (Nair 1962).
Pondicherry	*B. bipalmulata* (Lamarck) (Lamy 1929).

15. **Bankia bipennata** (Turton)

Madras	*B.* (*Neobankia*) *denticuloserrata* Daniel (Daniel 1956, 1958). *B.* (*Neobankia*) *lineata* Nair (Nair 1955a; Daniel 1958).
Pamban, Rameswaram (Tamil Nadu)	*B.* (*Plumulella*) *lineata* (Nair) (Nair 1962).
Visakhapatnam	*B.* (*Plumulella*) *lineata* (Nair) (Nagabhushanam 1960).

16. **Bankia carinata** (Gray)

Adirampatnam (Tamil Nadu)	*B.* (*Bankiella*) *indica* Nair (Nair & Gurumani 1957a).

Calcutta	*B. carinata* (Nair 1964).
Cochin	*B. carinata; B. edmondsoni* (Nair 1964). *Bankia* (*Bankiella*) *carinata* Gray, *Bankia* (*Bankiella*) *consularis* Moll (Saraswati 1964).
Godavary estuary, near Yanam	*B.* (*Bankiella*) *edmondsoni* Nair (Ganapati & Rao 1959).
Madras	*B.* (*Bankiella*) *indica* Nair, *B.* (*Bankiella*) *edmondsoni* Nair (Nair 1954, 1956). *B.* (*Bankiella*) *consularis* Moll, *B.* (*Bankiella*) *carinata* (Gray) (Daniel 1958).
Mylapore, Madras	*B.* (*Bankiella*) *indica* Nair (Nair 1954).
Pamban, Rameswaram (Tamil Nadu)	*B.* (*Bankiella*) *indica* Nair (Nair 1962).
Tondi (Tamil Nadu)	*B.* (*Bankiella*) *edmondsoni* Nair (Nair & Gurumani 1957a).
Visakhapatnam	*B.* (*Bankiella*) *carinata* (Gray) (Nagabhushanam 1960).

17. **Bankia campanellata** Moll and Roch

Bombay	*B.* (*Liliobankia*) *campanellata* Moll and Roch (Palekar, Santhakumaran & Bal 1964).
Cochin	*B. campanellata* (Nair 1964), *Bankia* (*Liliobankia*) *campanellata* Moll and Roch (Saraswati 1964).
Godavary estuary, near Yanam	*B.* (*Liliobankia*) *campanellata* Moll and Roch (Ganapati & Rao 1959).
Madras	*B.* (*Liliobankia*) *campanellata* Moll and Roch (Daniel 1958; Nair 1964).
Mylapore, Madras	*B.* (*Bankia*) *bengalensis* Nair (Nair 1954).
Sunderbans (West Bengal)	*B.* (*Liliobankia*) *campanellata* Moll and Roch (Roonwal 1966).
Tributary of Ganges river	*Teredo campanulata* 'Deshayes' Sowerby (Clessin 1893).

Visakhapatnam	*B.* (*Bankia*) *setacea* (Tryon) (Nagabhushanam 1955). *B.* (*Liliobankia*) *campanellata* Moll and Roch (Nagabhushanam 1960).

18. **Bankia nordi** Moll

Bombay	*B. nordi* Moll (Santhakumaran 1966).
Pamban, Rameswaram (Tamil Nadu)	*B.* (*Bankiella*) *nordi* Moll (Nair 1962).
Sajnakhali (West Bengal)	*B.* (*Nausitora*) *sajnakhaliensis* Rajagopal (Rajagopal 1964; Roonwal 1966).

19. **Bankia rochi** Moll

Bombay	*B.* (*Bankiella*) *minima* Blainville, *B.* (*Neobankia roonwali* Rajagopal (Palekar, Santhakumaran & Bal 1964).
Sunderbans (West Bengal)	*B.* (*Neobankia*) *roonwali* Rajagopal (Rajagopal 1961; Roonwal 1966).
Visakhapatnam	*B.* (*Plumulella*) *thielei* Roch (Nagabhushanam 1960).

Genus *NAUSITORA* Wright

20. **Nausitora dunlopei** Wright

Hoogli River (Calcutta)	*Nausitora dunlopei* Wright (Wright 1864).
Royapuram and Triplicane, Madras	*B.* (*Nausitora*) *madrasensis* Nair (Nair 1954, 1956).
Sajnakhali (West Bengal)	*B.* (*Nausitora*) *lanceolata* Rajagopal (Rajagopal 1964; Roonwal 1966).
Visakhapatnam	*B.* (*Nausitora*) *excolpa* Bartsch (Nagabhushanam 1955), *B.* (*Nausitora*) *dunlopei* Wright (Nagabhushanam 1960).

21. **Nausitora hedleyi** Schepman

Bombay	*Nausitora hedleyi* Schepman (Santhakumaran 1971).
Ernakulam, (Cochin) (Kerala State)	*B.* (*Nausitora*) *gabrieli* Nair (Nair 1955). *Nausitora hedleyi* Schepman (Nair 1964; Saraswati 1964).

Madras	*B.* (*Nausitora*) *gabrieli* Nair (Nair 1956).
Pulicat lake (Tamil Nadu)	*B.* (*Nausitora*) *hedleyi* Schepman (Nair 1963).

Genus *NOTOTEREDO* Bartsch

22. **Nototeredo edax** (Hedley)

Bombay	*Nototeredo edax* Hedley (Santhakumaran 1971).
Godavary estuary, near Yanam	*T.* (*Dactyloteredo*) *juttingae* Roch (Ganapati & Rao 1959).
Tondi (Tamil Nadu)	*T.* (*Psiloteredo*) *tondiensis* Nair and Gurumani (Nair & Gurumani 1956, 1957a).
Visakhapatnam	*T.* (*Teredora*) *thomsoni* Tryon (Nagabhushanam 1955). *T.* (*Dactyloteredo*) *juttingae* Roch (Nagabhushanam 1960).

FAMILY PHOLADIDAE

SUBFAMILY MARTESIINAE

GENUS *MARTESIA* (LEACH) SOWERBY

SUBGENUS MARTESIA (LEACH) SOWERBY

23. **Martesia (Martesia) fragilis** Verrill & Bush

Cochin	*Martesia fragilis* (Nair 1964).
Madras	*M.* (*Martesia*) *fragilis* Verrill & Bush (Daniel 1958; Daniel & Srinivasan 1956; Srinivasan 1959).
Porto Novo (Tamil Nadu)	*M.* (*Martesia*) *fragilis* Verrill & Bush (Srinivasan 1959).

24. **Martesia (Martesia) striata** (Linnaeus)

Bombay	(Palekar & Bal 1955).
Calcutta	(Annandale 1923).
Cochin	(Erlanson 1936).
Kayamkulam (Kerala State)	(Srinivasan 1959).

Krishna estuary (Andhra Pradesh)	(Rao, Murthy & Krishnakumaran 1957).
Krusadai Island (Tamil Nadu)	(Satyamurthy 1956).
Madras	(Daniel & Srinivasan 1956; Daniel 1958; Srinivasan 1959).
Porto Novo (Tamil Nadu)	(Srinivasan 1959).
Tuticorin (Tamil Nadu)	(Srinivasan 1959).
Visakhapatnam	*M.* (*Martesia*) *striata* Linnaeus, *M.* (*Diploplax*) *americana* Bartsch (Nagabhushanam 1955).

Subfamily XYLOPHAGINAE

Genus *XYLOPHAGA* Turton

25. **Xylophaga** sp.

Mahanadi estuary, off Puri (Orissa State)	(Ganapati & Rao 1961).

Two more species of shipworms, namely *Teredo* (*Teredo*) *elongata* Quatrefages and *Teredo* (*Teredo*) *navalis* Linnaeus, have also been reported from Indian waters. Of these *T. elongata,* mentioned by Becker (1958), is a *nomen dubium.* Similarly *T. navalis* recorded from Visakhapatnam (Nagabhushanam 1955) is probably *Teredo bartschi* Clapp and that recorded from the Madras coast (Nair 1955, Nair & Gurumani 1957a) is probably *Teredo furcifera* Martens. (Turner, personal communication.)

Thus, although a survey of the literature on *Teredinidae* from the Indian coasts shows the presence of about 57 species, only 22 of them are actually valid in the light of the new classification put forward by Turner (1966). She has redefined the genera on the basis of the anatomical characters of the soft parts, and of the 14 teredinid genera recognised by her, 10 are represented in Indian waters. Among the various species of molluscan wood-borers, *Lyrodus pedicellatus* Quatrefages, *Dicyathifer manni* (Wright), *Teredo furcifera* Martens, *Bankia campanellata* Moll and Roch, *Bankia rochi* Moll, *Bankia carinata* Gray and *Martesia striata* Linnaeus are the most destructive and widely distributed.

It is necessary to mention in this connection that there are vast stretches of coast line which still remain unexplored and the richness of the already recorded borer species indicates that a thorough survey all along the coast can reasonably be expected to bring to light several manuscript and making the necessary corrections.

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Reviews

1. THE ENVIRONMENTAL REVOLUTION. A GUIDE FOR THE NEW MASTERS OF THE WORLD. By Max Nicholson. pp. 366 (22.5 × 15 cm) with 56 Black-and-White photographs. London, 1970. Hodder and Stoughton Ltd.

Max Nicholson is one of the giants of the environment movement. From his youngest days he was passionately interested in birds and at a very early age he wrote in quick succession six books on different aspects of birdlife. His penetrating mind soon acquired a synoptic view of nature and he recognized the vital connection between all forms of life including man to the environment around it. Being also deeply immersed in sociology and economics he could take a rounded view of the role of the conservationist and as the founder director of the Nature Conservancy in England he moulded the institution to serve the best needs of the country. 'It is pointless to express aspirations he says 'without being able to show that the task is administratively practicable and politically sustainable'. Being confident of the role of conservationist and being in a position to demonstrate so ably the value of good land use practices for economic progress he is, in spite of being the keenest of naturalist, able to enter into a meaningful dialogue with the administrator. The global view of this book and the wealth of references provided makes it an education by itself.

One of the ecological challenges of our country is to persuade the administrator that wetlands and forests are not luxuries to be drained or hacked down but that these are in fact invaluable assets which should be conserved. In the chapter on the Earth and its Living Pattern, the author cites the case which shows how agriculturists benefit if the ecology of neighbouring lands is not disrupted. For many years the agricultural interests in Huntingdonshire were opposed to the maintenance of a peat bog and the 'sterilisation' of much valuable land. It took them a long time to realize that the vast sponge of peat soaked up huge quantities of flood water which would otherwise frequently inundate much farmland. 'Although normal rainfall in this area is lower than almost anywhere in England it is liable to severe sudden downpours, which in 1968 caused deep flooding of nearby villages in early July and again in August. This is one of the most efficiently and scientifically farmed areas in Europe and it is a revealing commentary on the limited environmental understanding of agricultural authorities and of farmers that even in such circumstances it should have needed the chance presence of a nature reserve to prove such an elementary point.'

We have a long way to go to understand living processes of the earth and this book stimulates us to ask the right question about the manner in which the natural ecosystems of our country should be made to fuse with the technosphere which is shaping so rapidly around us.

Z.F.

2. A FIELD GUIDE TO THE SNAKES OF SOUTHERN AFRICA. By V. F. M. Fitzsimons, pp. 221 (13 × 20 cm), with 32 plates including 12 in colour. London, 1970. Collins. Price £2-10 net.

This book deals with 138 species and subspecies of snakes, of which 70 are endemic.

The introduction of 22 pages covers a comprehensive survey of their origin and classification, external covering, shapes and sizes, colours and markings, habitat and distribution, food, reproduction, hibernation, senses, locomotion, longevity etc., etc. Each aspect though sometimes only a paragraph, is comprehensively dealt with and reflects the wide experience of the author, both in the field and in the museum.

The key to identification is based entirely on colour and considering that several species in India show widely differing colour phases, one is a little hesitant to accept it. However, the main text in which the species are listed one by one, refers to the scalation and this together with the occasional figures and many illustrations no doubt ensures correct identification.

As in India, the multitude of snakes, including large and poisonous species, has left their mark on the culture and beliefs of the local people and there is an interesting list of fallacious beliefs, many of which are similar to those prevalent in India.

Opposite the title page, it is stated that the Peterson Identification System is used and that arrows indicate the most important field marks. No arrows are visible in any of the illustrations in this book; presumably the remark applies to other books in the series.

This is an excellent contribution to a useful series of field guides. It is unfortunate that with all the materials available in our country, no attempt has yet been made to produce a similar book for our snakes, lizards and frogs.

H.A.

3. PROTEACEAE. Botanical monograph no. 6. By C. Venkata Rao. pp. vx + 208 (23.5 × 15.5 cm) with 9 plates, 75 figures. New Delhi,

1971. Council of Scientific and Industrial Research. Price Rs. 34.00, *Sh.* 68/-, $ 11.00.

This monograph keeps to the good tradition of these published by the CSIR, New Delhi. The forwarding note by H. Newton Barber recalls the author's visit to Tasmania under the Colombo Plan, when he was introduced to the Australian Proteaceae. Since then Venkata Rao continued his studies of the morphology, cytology and taxonomy of the group. The studies have culminated in the preparation of this monograph which came out of the press only a few days after the author's death.

Chapter i gives the distribution and economic importance of the family Proteacea. Chapter ii discusses the morphology of the vegetative and reproductive parts of the plants. Chapter iii discusses the anatomy of the leaf, flower and fruit in the family. Chapters iv and v give an account of the development of endosperm, embryo and seed. Chapter vi gives cytological data and classification of the family based on various criteria. The last chapter gives the fossil history and discusses the evolutionary trends. An extensive bibliography and index are appended at the end.

As a result of his detailed studies the author concluded that the nectary is only an enation and therefore the flower is primitively monochlamydeous. The book gives a new classification of the Proteaceae (mainly based on Brown's) and gives a good historical review of the classification. The origin and spread of Proteaceae is discussed in detail and various views on evolutionary trends are presented in a lucid manner. Similar monographs on groups of plants well-represented in India would be most welcome to the students of botany in India. The production standard of the book is very good.

P.V.B.

4. RESEARCHES ON LIVING PTERIDOPHYTES IN INDIA, BURMA AND CEYLON. By N. P. Chowdhury. pp. viii + 80 (14 × 21.5 cm) with 5 plates. Bombay, 1971. Asia publishing house. Price Rs. 22.00.

Dr. N. P. Chowdhury, senior lecturer at the University of Delhi, has attempted to present a brief but comprehensive survey of pteridological studies in India, Burma and Ceylon. According to the author, this book is compiled to help the postgraduate and research level studies, and it highlights the contributions on the subject upto 1968.

This 80 page book contains 20 pages of bibliography enlisting 344 references including 98 from the proceedings of Indian Science Congress some of which may not be regarded as scientific publications. It contains 6 pages of index of names. The 50 page review of researches is treated under 16 families of pteridophytes including 6 subfamilies of Polypodiaceae. The author seems to follow Christenson's classification.

This book is an improved production of the Progress of Science in India—VI. BOTANY (Pteridology) by the author and P. N. Mehra, 1959.

In the absence of any other comprehensive review on the subject, this publication should find a place in the libraries. The price of the book may deter many research workers in India to acquire personal copies.

P.V.B.

5. NGORONGORO — THE EIGHTH WONDER. By Henry Fosbrooke. A Survival Special on African Wildlife (ed. Colin Willcock). pp. 240 (21 × 15.5 cm) with 15 coloured, 12 black-and-white photographs, 7 figs., 6 tables, end-paper maps. London, 1972. Andre Deutsch. Price £3.95.

Among the enviable repletion of National Parks and Game Reserves that E. Africa possesses the Ngorongoro Crater in Tanzania is certainly unique and may justly be regarded as one of the wonders of the world. It is a vast caldera or explosion-crater, 9 miles across and 102 square miles in area, encircled by a mountain wall 2000 ft or more in height. The crater floor itself, 5000 ft above sea level, is for the most part a great expanse of grassy plain alternating with acacia woodland, swamps and lakes and occasional outcrop hills. The crater teems with almost every form of wildlife including a large variety of birds, and is in effect an epitome of the country around the rim—the highlands rising from the Serengeti plain—now known as the Ngorongoro Crater Conservation Area. When the animals first entered the Crater is not known, but most of them are permanent residents there. The steep crater wall, though not an insuperable barrier, offers little temptation to the animals inside to climb out, or the animals outside to descend, life conditions and security being equally suitable in both places.

The author, Henry Fosbrooke, was Conservator of the Ngorongoro Conservation Area for a number of years prior to the political changes in E. Africa. It is apparent that he was deeply interested in the welfare of the human population as well as the country's rich heritage of wildlife. As such, he could take a balanced view of the compromises essential for making the best use of the land from the forestry, tourism and sociological standpoints. Formerly the Crater formed part of the Serengeti National Park. It, and a considerable surrounding area—The Ngorongoro Conservation Unit—was excised in 1959 in order to conserve its natural resources while at the same time safeguarding the interests of the indigenous Masai, a pastoral people who were long settled there with their herds of cattle. The author was always opposed to the entire removal of the Masai from the Crater, against the suggestion of 'experts'. It is now realized that their cooperation has been the most effective way of preserving the Black rhino whose population had become seriously depleted by commercial poaching. Generous rewards for informers and heavy fines and imprisonment for poachers, in addition, produced the desired results. From a mere 19 in 1958 the number of rhinos in the Crater had increased to 109 by 1966, i.e. just over one beast per sq. mile.

From tested practical experience, Fosbrooke puts forward many wise observations and suggestions which are of direct relevance to our own efforts to develop National Parks, Wildlife Sanctuaries and promote wildlife tourism in India. Many of the problems are the same in both countries, or differ only in degree, therefore what he has to say is well worth a careful study by those responsible here.

In spite of its heavy stock of Masai cattle and of large wild herbivores, erosion is not a serious problem in the area as yet, but its man-made acceleration as a result of rapidly expanding tourism must be vigilantly guarded against. To restore the ravages of uncontrolled fires and to ensure an adequate supply of domestic fuel—even for beautifying the surroundings of tourist lodges etc.—the author justifies the planting of *indigenous* trees in specially demarcated parts of wildlife and wilderness areas, but is strongly critical of *exotics* such as *Eucalyptus* and *Araucaria*. (Indian forests and tourism planners N.B.!).

Descriptions of the large animals of the Crater that follow, the carnivores and the herbivores—predator and prey—with their interactions among themselves and with the biotope as a whole make fascinating reading. Giraffe and impala are curiously about the only two absentees from the Crater though common enough in the surrounding area above the rim. Absence of the former may be accountable by the absence or paucity of acacia trees, its staple food, but the case of impala is less easy to explain. The total absence of fish in the Crater is another unexplained anomaly.

The Spotted Hyaena is apparently not the scavenger it is popularly believed to be. It is lauded as a predator and effective check on the over-increase of wildebeeste, of which the population in the Crater alone was given as 10,438 in the 1966 census. (Wildebeeste blackening the plains with their bewildering numbers, especially on migration, is without doubt one of the most impressive sights for the safari tourist in East Africa). These hyaenas are known to attack man when food is scarce. It will be recalled that there were frequent reports of the same thing also happening in India a few years ago when large-scale jungle clearing for mechanised farming was in progress in the U.P. tarai. The Cheetah's chasing speed, given in books and commonly credited as 60 to 70 mph has been greatly exaggerated according to the author. The proven speed is about 45 mph—which is fast but not phenomenal.

The latter parts of the book deal largely with matters anthropological—the past and present history of man in the Conservation area: the romantic discovery of remains of ancestral man one million seven-hundred and fifty thousand years old and up to relatively recent times in the Olduvai Gorge (outside the actual Crater), made famous by the excavations of Dr. and Mrs. Leakey. The remains of gigantic sheep-like beasts with a horn-spread of over 6 feet which co-existed with early man throw light also on the topography and fauna of the region in prehistoric times. Present-day tribal man—the various tribes and sub-tribes inhabiting the area and the impact of their cattle-keeping customs upon the gazing resources of wildlife are some of the topics discussed. Various suggestions are made of how the viability of the environment could be maintained by a system of migration or 'trans-humance' as practiced in Norway, Switzerland and elsewhere, of moving up and down mountains with the snow line and lush conditions, as the only feasible method for finding sufficient grazing for the herds. A permanent home and a seasonal one for the cattle owners could thereby be established. The vicissitudes and history of the Crater since the first European colonization in the last decade of the 19th century —the growing expansion of tourism in recent years, the building of roads and lodges, the increase of motor traffic and the problems of maintaining a balance between the conflicting demands of tourism and nature conservation—hold much of relevance for our own as well as other wildlife tourism-developing countries.

The last chapter poses the question 'Can Ngorongoro survive?' and answers that since zoologically the Crater is a part of a larger ecosystem, it can survive only if the entire surrounding highland forest —on which it is dependent for its water resources—is conserved by wise optimum multiple land use—agriculture, forestry, wildlife, tourism —involving a judicious compromise between compatible and incompatible factors and complete elimination of those that are entirely incompatable. The Crater cannot exist in isolation 'as a glorified Whipsnade'; it is essential for it to be able to draw reinforcements of animals from the reservoir of the surrounding highlands and Serengeti National Park.

Suggestions are mooted for developing these surrounding areas to meet the various conflicting pressures. The conclusion is that Economics of expanding tourism offer the best chances for the Crater's survival. With the development of lodge facilities the number of tourists is increasing by leaps and bounds every year: from about 6000 in 1961, the Crater attracted over 70,000 in 1970!

A postscript reviews the situation during the 2½ years since the author left the Ngorongoro Conservation Area. It ends on an optimistic note: the prospect of survival is bright if present beneficent trends in policy and administration continue.

Ecologists and conservationists alike—not to mention safari tourists and intending visitors to E. Africa—will find this comprehensive account of the World's unique 8th Wonder of absorbing interest. Many of the author's observations on conservation vis-a-vis wildlife tourism problems are equally applicable to Indian conditions today, and our planners should find them of much practical import.

S.A.

6. POLLUTION: ECONOMY AND ENVIRONMENT. By Peter A. Victor. pp. 247 (22 × 14 cm) with 48 tables. London, 1972. George Allen & Unwin Ltd. Price £5.85.

For centuries man has used natural resources, the land surface, air, water etc. without paying for them. The resources of nature were so vast that they appeared to be inexhaustible. With the advance of technological civilization, human population and its encroachment on the environment, increased by leaps and bounds. There was not only less of the earth left in its natural state, but the demands of the growing human population on the resources that remained also increased. At the same time, the dumping of human wastes and the end products of technological processes which could not be easily assimilated into the natural cycle of events, increased apace. As a result, we have been depleting our environment and have begun to realise that replenishment of these resources is essential if our civilization is to survive. For instance it has been estimated that the United States of America consumes annually 40 per cent more oxygen than its trees and forests are able to produce. At some stage means must be found to make good this deficit. The conversion of wastes into material fit for natural processes is complicated and expensive and, in many instances the technology for such conversion has yet to be developed. What then shall we do? The logical solution, to have no further industry until methods are found to reverse this resource drain, is manifestly impossible both economically and psychologically. But we can adopt a more rational approach to individual industries and processes if we can evaluate the degree of damage, both in terms of actual use of natural resources and in polluting or damaging the environment in ways which harm the community and future generations. This is the province of the economist.

In traditional economic practice, the cost of a product is calculated on the basis of raw materials and services paid for, while natural resources are considered as externalities which do not contribute to the cost. Economists have been considering, in recent times, evaluation of the raw materials from natural resources, as well as of the cost to the community due to dumping of wastes and pollution, since these must ultimately be "made good" if the community has to survive. The example of water is easily understood. If an industry uses 1000 gallons of fresh water for its processes, and discharges it in polluted form, the cost of this water, at standard rates (even where it is actually obtained free from a natural source) and the cost of purifying the polluted waste so that it can be reintroduced into natural water sources without harm, can both be legitimately considered part of the manufacturing cost. Similar calculations can be made for other natural resources though it may involve a number of presumptions and approximations which may need considerable revision in time. Utilizing such approximations, economists are attempting to derive formulae and equations for input output calculations which would give the true cost to the community of any industrial product or service industry. The mathematical formulae proposed by various authors are discussed and the author gives further modifications of his own to obtain a more realistic assessment. The mathematical discussion, involving the use of matrices and set theory, form the greater part of the book and are beyond the competence of this reviewer to discuss. However, the basic argument is clear that a true costing taking account of ecological considerations in input output calculations, is necessary for every industrial activity, and that when the true costs are estimated, it would be possible by fiscal measures and price adjustment, to encourage the less harmful, in environmental terms, alternatives, and to encourage expense on measures to repair the damage to the environment. Further, it maybe possible to calculate in advance, the true cost of any new technique or modified process which is proposed, to enable us to decide whether it is worth while. As an example, he gives the calculation of relative costs of transportation by private cars and by public vehicles to show the high cost of the former and to suggest measures which could encourage a change over to greater use of the latter.

The success of such calculations would naturally depend on the accuracy of the data available for each industrial process. The author has given tables derived from data collected by the Dominion Bureau of Standards of Canada on the use of natural resources by industry and the wastes and effluents produced. The industries are classified into 40 groups, which makes interpretation in matters of detailed comparison sometimes inexact. However, with increasing studies of this nature the collection and tabulation of data will doubtless become more detailed an accurate.

This book is written for the economist, not for the naturalist. However, the type of study attempted is important for every person interested in conservation of nature, since it attempts to impress, in quantitative terms, the ideas which all conservationists desire to impress upon the community.

A.N.D.N.

7. THE FASCINATION OF REPTILES. By Maurice Richardson. pp. 240 (24 × 16.5 cm) with 8 coloured plates, 33 drawings in text. London, 1972. Andre Deutsch. Price £3.25.

Maurice Richardson is not just a herpetologist but an engaging writer with a passionate interest going back to childhood, in reptiles of all kinds. His knowledge of reptilia is not just scientific; it is erudite and literary with more than a touch of whimsy to it.

In an earlier autobiographical volume of prep school memories *Little Victims,* Richardson writes how his passion for reptiles and amphibians was at its height when he was barely six. His favourite reading then was the volume on Reptiles in the Rev. J. G. Wood's NATURAL HISTORY and he describes the lizards, crested newts, adders and slow-worms that he caught with great delight and dexterity.

THE FASCINATION OF REPTILES is not another routine book that lists uncommon snakes and lizards. While it does not pretend to equal classics like Ditmars REPTILES OF THE WORLD or Richardson's own childhood mentor's NATURAL HISTORY, it is immensely readable and casts its spell on you from the very first paragraph. Richardson more than dazzles you with his knowledge of reptiles—mostly from personal observation—with notes on the idiosyncracies or peculiarities of individual species: he spices his book with anecdotes and asides and his own lively comments.

The structure of the book is uniquely Richardson's. He explains the classification and evolution of reptiles in a manner simple and interesting enough to wholly engage the attention of even a non-scientific reader. After this he branches into the different orders, devoting a chapter to the chamaeleon (his most favourite of all reptiles) and splitting the sub-order *serpentes* into pythons and boas, *elapidae* and *viperidae.*

Despite his preoccupation with the green mamba he is quite generous toward pythons and anacondas. The royal python of West Africa is 'a dear little python with a most gentle disposition and genuinely pleasing personality'. This is rivalled only by the Indian rock python, the lighter coloured subspecies of which he describes as the possessor of a 'charming, friendly disposition' and recommends highly as a pet for playtime or show business. A sequel to this is the rather hair-raising account of Miss Ongawa, a Japanese cabaret artiste who includes an act with a live snake in her bag of tricks. 'She inserts the head of a living snake into her mouth and guides it so that the head emerges through one of her nostrils...... Miss Ongawa then proceeds to eat the snake alive'. I was sorry to observe that Richardson had failed to mention—or observe?—the species of this particular snake.

Apart from these delectable asides, Richardson gives you a great deal of scientific information and observation. On the courtship and mating habits of the sand-lizard, for instance, or the ability of the crested lizard of the Nevada deserts to endure temperatures of 115°F (the body cavity is lined with black which may help to protect it from ultra-violet rays). It is a pity that parts of the book, particularly the chapters on *elapidae* and vipers, get a bit breathless as there is so much information crammed into them.

The range of Richardson's knowledge and herpetological lore is impressive and he easily demolishes accounts of snakes that all of us have read, pointing out 'the herpetological howlers' committed by Kipling or the inaccuracies in Conan Doyle's THE SPECKLED BAND. He pays warm tribute to eminent herpetologists like Dr. Schmidt of the Chicago Natural History Museum, the Belgian, Dr. Rollinat and Constantine Ionides the naturalist and snake catcher to whom there are frequent references.

The book is illustrated with line drawings and colour plates by Shaun Milne. An unexpected and quite delightful bonus is the anthology of reptilian belles-letters which ends the book with a fine flourish. The poems and extracts here start way back with Virgil and Ovid (shades of Richardson's prep school days—were these in part responsible for his interest?) and go through D. H. Lawrence (his *Baby Tortoise* is wonderfully evocative as anyone who has possessed one will confirm), Collette and Desmond Morris.

An exhilarating book. If, like me, you have an unreasonable dislike of reptiles—left over from a nursery horror of creepy-crawlies?—Maurice Richardson's book will certainly arouse your interest in this class of vertebrates. That is, if he fails to win you over completely.

NEELA D'SOUZA

8. THE OXFORD BOOK OF BIRDS. Pocket Edition. By Bruce Campbell. Illustrations by Donald Watson. pp. 207 (15.5 × 11.5 cm),

including 94 colour plates. London, 1972. Oxford University Press. Price £1.35 in U.K.

This is a revised pocket edition of a book published in 1964.

The 94 colour plates, each with several species in their varying plumages, illustrate most of the birds likely to be met with, while all the 468 species recorded from the British Isles are referred to in the text.

Curiously, the title gives no indication of the area dealt with. The reduction in size has the colours slightly darker than in the first edition, but the pictures are excellent. One wonders when such a pocket book will be available for India.

H.A.

9. THE WEALTH OF INDIA: A Dictionary of Indian Raw Materials and Industrial Products. Raw Materials—Vol. IX; Rh to So; pp. xxxviii + 472 + xiv (27.5 × 21.5 cm), with 7 plates and 144 text-figures. New Delhi, 1972. Council of Scientific & Industrial Research. (Price not shown).

It is gratifying to note that the ninth volume of this series, to be completed in ten volumes, has been issued after an interval of about three years since the publication of the previous volume in 1969. It is hoped that the tenth volume of this outstanding work of reference will be published without delay, which is not uncommon these days in important publication activities and that on completion of this monumental task a revision will be undertaken as soon as possible.

This volume which maintains the high standard associated with the series contains the largest number of entries so far: 500 relating to plants and 5 each relating to minerals and animals including animal products. The important topics covered include: *Ricinus* (Castor), Road Metal, Rose (including garden roses), *Saccharum* (sugarcane), Salt, *Santalum* (sandal), *Semecarpus* (marking nut), *Sesamum* (sesame), Silk and silk-worms, Sillimanite, *Solanum* (brinjal) and *Sorghum* (jowar).

The articles are useful to laymen as well as scientists and have been compiled after a great deal of study and investigation, a number being based on contributions from specialists. Every effort has been made to present precise and comprehensive information. A notable feature of this alphabetical dictionary is the index which gives with common English names, the names in Indian languages, in addition to regional and trade names. The index contains some three thousand entries and the arrangement will be appreciated by readers. This volume has been printed in 10/11 point type, compared to 11/12 of the previous volume, but as glossy paper has been used and the work is well printed, the change has not affected the readability.

There appears to be an omission on p. 99 where the Marathi name of sugarcane has not been listed.

G.V.B.

Miscellaneous Notes

1. DHOLE OR INDIAN WILD DOG (*CUON ALPINUS*) MATING

On 10 September 1972 between 06.45 and 07.40 hours I had a pack of dhole under observation from a ground hide on the western bank of the Sigur river in the lower plateau of the Nilgiris not far from the Mudumalai Sanctuary. I counted 12 dhole of which 5 were subadults. The subadults (9 to 11 months old cubs) were playing in the water with, what I afterwards discovered to be, the putrid remains of a langur. Some of the adults were resting on the dry half of the river bed and the others were lolling, occasionally sniffing the genitals of each other.

One of the dhole, a dog, grew suspicious and ran down the river bed towards me until it was opposite my hide, only the water spread of about 10 metres separating us. It barked or rather yapped in my direction. As I did not give myself away it went back to the main group which was some 50 to 60 metres away. Soon the same dog, along with two companions returned to make further investigations. While it and another dhole stopped in the low undergrowth on the opposite bank about 30 to 35 metres away, the third dhole with a large growth on its chin ran forward and stopped on the slope about 25 metres away. All three sat looking in my direction, more curious than suspicious.

It soon became apparent that the dog's companion on the bank was a bitch, as the dog after smelling her genitals tried to mount her. Twice the bitch repulsed the dog's advances by sitting tight and snarling. The third time the dog succeeded. The copulation took place in a crouching position, more in the manner of lions and tigers than dogs which stand on all fours.

At the moment of copulation the bitch whimpered, sounding like a juvenile begging for favour. This attracted half the pack. As half a dozen dhole rushed towards the pair, I apprehended an attack. Instead, some actually crawled up to the pair in a submissive manner, wagging their tails and whimpering. The adults circled the pair and went away. But two subadults (probably the cubs of the bitch) remained in the vicinity a while longer.

The copulating pair were tied together, dog fashion. But unlike dogs they did not stand back to back nor were they engaged in a tug-of-war. But they lay flat on their sides, their bodies forming a semicircle and facing each other. They spent the 7 minutes they remained tied occasionally struggling to get up. On one occasion they nuzzled each other at the corners of the mouth, as dhole cubs do when begging for food.

The moment they got untied, the male moved away yelping. This again attracted the pack. Five dhole, two adults and three subadults surrounded the bitch. One of the adults smelt her genitals before moving away. But the subadults showed greater interest and smelt her all over and one licked her as she lay on the ground.

The male was not the biggest dog in the pack and it was not one of those which had shown interest in the females earlier. When the pairing took place the pack was all around thus disproving the popular theory that pairing dhole strike out on their own. In a well knit pack, breeding would appear to interest the whole pack and ceases to be the private affair of a pair.

The dhole bitch with an unmistakable growth on her chin promises to make identification of the pack simple and further observations interesting.

"CANOWIE"
COONOOR-1,
NILGIRIS,
October 30, 1972.

E. R. C. DAVIDAR

2. ON THE DOMESTICATION OF THE OTTER BY FISHERMEN IN BANGLADESH

The use of cormorants for fishing is well known. Apparently, in certain areas of Bangladesh (Jessore District), certain tribes of fishermen have an age-old tradition of domesticating otters for catching fish. This note is based on the enquiries made by the author during two visits to Bangladesh in 1972. As trained animals may be sold at a price of Rs. 800|- or more the advantages in fishing with them must be quite considerable.

The trained otters begin to bark at about 4 a.m. which is the fishermen's time for fishing.

The fishermen carry the otters with them in their boats to the fishing grounds. Once the nets are set in the water, the otters are released and they herd the fish into the net. The otters also catch large fishes sometimes weighing more than the otter. These big fish the otters bring to the boat, for the fishermen to collect. Small fish are consumed by the otters during the hunt.

J/146, PAHARPUR ROAD,
GARDEN REACH,
CALCUTTA - 24,
January 29, 1973.

R. N. BISWAS

3. A NOTE ON THE BIRTH OF A MALAYAN GIANT SQUIRREL (*RATUFA BICOLOR*) IN CAPTIVITY

A female Malayan Giant Squirrel (*Ratufa bicolor*), living with a male of the same species since 17 June, 1971 at Nandankanan Biological Park, Orissa gave birth to a female young on 15 July 1972 in one of the wooden boxes kept inside the squirrel cage.

At birth the young weighed 77 gm and measured 29.5 cm including the 12.5 cm long tail. The upper parts of the body coat were black whereas the under parts were light brown. The eyes were closed at birth and opened on the 22nd day (5 Aug. '72). At the age of two weeks the young was fully haired and the brown colour of the underparts gradually turned to white. The mother used to collect leaves and small branches from a plant inside the cage and keep inside the wooden box probably to use as bedding material or to conceal the baby. The mother carried the young by her teeth till the young was 8 weeks old while she jumped from one box to another. The baby was lifted by holding a fold of skin at the back with the teeth, or lifted the young by holding the base of one of the hind limbs. At times the young one used to make the typical giant squirrel call, immediately drawing the attention of the mother. The young was once seen taking banana for the first time at the age of five weeks and was able to come out and get into the wooden box kept at a height of about 90 cm from the ground on a wooden post at the age of eight weeks. It measured 59 cm from nose tip to tip of tail and weighed 445 gm at the age of two months.

NANDANKANAN BIOLOGICAL PARK, L. N. ACHARJYO
P.O. BARANG, CUTTACK DT.

WILDLIFE CONSERVATION OFFICER, R. MISRA
ORISSA, OLD SECRETARIATE BUILDINGS,
CUTTACK - 1,
November 28, 1972.

4. A WHITE INDIAN GERBIL, *TATERA INDICA INDICA* HARDWICKE

A pregnant female Indian Gerbil, collected from natural pastures in Jodhpur, delivered a litter of four in the laboratory. One of the offsprings, a female, was much paler than the rest. When pelage developed, it bore pure white hair over the entire body including the tassel at the tip of the tail, the eyelashes and hair on the plantar surface. The exposed skin was devoid of pigmentation and was transluscent white. But the iris was black unlike in albinos.

As the young ones started growing, the white female was slower in movements and less aggressive. Its reaction to external stimulus also was rather slow. It always kept its eyelids half closed. Its growth rate was, however, similar to others in the litter. When it weighed 100 gm, one of the males was released in its cage for mating. The female died at the age of 201 days without breeding, and its vagina was imperforate. Autopsy results showed that all its internal organs were normally developed.

Romer (1949), Harrison (1950), Harrison and Lim (1951), Gibson-Hill (1950), Joshee & Kamath (1963) and Rajgopal & Mandal (1965) have reported and reviewed the observations on the occurrence of 'albinism' among commensal rodents. Most of these reports pertain to the genus *Rattus* and one to *Bandicota bengalensis*.

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JODHPUR, A. P. JAIN
October 20, 1972. B. D. RANA

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5. MUDALIAR OOTU — A LAST STRONGHOLD FOR THE RARE NILGIRI TAHR

Mudaliar Ootu, a perennial spring, is situated next to an old bungalow in the Western Ghats near Srivilliputhur in Ramnad district, Tamil Nadu.

Mudaliar Ootu is easily accessible from Pudupatti and Srivilliputhur. The hill track which had been well maintained in the past is now eroded by rain. Along the track one can see many birds including red spurfowl and grey junglefowl. It is not uncommon to see Malabar giant squirrels, common and Nilgiri langur, bonnet macaque, mongoose, mouse deer, hare, elephants and *Varanus* at different altitudes.

During the monsoon water is available throughout the trail but in summer water is restricted to some deep nullahs. Anyhow trekers can quench their thirst after reaching the bungalow at the Mudaliar Ootu.

Mudaliar Ootu Bungalow, surrounded by evergreen trees, is locally well known for its cool atmosphere, scenic beauty, and for the herds of Nilgiri Tahr or Ibex that are found on the peaks adjoining the Bungalow. The neighbouring peaks, Peimalai Mottai, Udumbu Theri and Veilkathanmottai, are covered with an abundant growth of lemon grass and *Phoenix humilis*. The precipitous rocky slopes of these peaks are the favoured haunts of the once abundant Nilgiri Tahr now reduced to a small population owing to excessive shooting. A sixty five year old hunter said that in his forty five years of shooting career he had bagged more than five hundred Nilgiri Tahr and that there are scores of hunters who have shot more than a hundred mainly for the pot. Like all goats the Nilgiri Tahr lives in small herds but the old males are often solitary. If the hunter could reach the herd unnoticed and remain hidden he can shoot down the entire herd. But once they get a glimpse or smell of man, they disappear into the deep valleys. Nowa-days the local hunters use well-trained dogs which sometimes corner the sure-footed animals and the hunters have an easy task of approaching the almost petrified animals and bringing them down unawares. It seems that the once abundant Nilgiri Tahr is fighting its last but vain battle on the precipitous rocky slopes of these hills which are not an impediment to the sure footed local hunters.

While standing on the Veilkathanmottai one can have a bird's eye-view of the surrounding hills. To anyone interested in the preservation of wild life the free movement of domestic cattle throughout the hills will be an unpleasant surprise. The thick forests around Mudaliar Ootu are devoid of big cats. Herdsmen boast of having eradicated by poisoning the food, the big cat population, which was fairly good five years back.

Inspite of this vandalism it is still possible to restore the Nilgiri Tahr and other wild life of Mudaliar Ootu area, if entry of cattle is prohibited and all types of hunting stopped. If action is not taken immediately Mudaliar Ootu will lose all its fine animals within five years and it will be populated only by elephants, man, and his domestic animals.

A. J. T. JOHN SINGH

SANKAR NAGAR,
NANGUNERI,
TIRUNELVELI DIST.,
TAMIL NADU,
June 26, 1973.

6. A NOTE ON AGE OF SEXUAL MATURITY OF TWO SPECIES OF ANTELOPES IN CAPTIVITY

This communication deals with the age of sexual maturity of the female of two species of antelopes observed at Nandankanan Biological Park (Orissa).

1. **Blackbuck** (*Antilope cervicapra*)

A female blackbuck born at the Park on 25.ix.1969 gave birth to a young for the first time on 20.ii.1972 at the age of 2 years, 4 months and 27 days. Another female blackbuck born at the Park on 20.i.1970 gave birth to a young for the first time on 22.ii.1972 at the age of 2 years, 1 month and 3 days. These females were kept along with adult males throughout this period. Taking the gestation period as about 6 months (Asdell, 1964: PATTERNS OF MAMMALIAN REPRODUCTION, pp. 617), the age of sexual maturity of these animals can be said to be not more than 1 year, 10 months and 27 days or 1 year and 11 months and 1 year, 7 months and 3 days or 1 year and 7 months respectively.

There is no mention of age of sexual maturity of this species in the available literature.

2. **Nilgai** (*Boselaphus tragocamelus*)

A female nilgai born here on 13.iii.1968 gave birth to a dead male young for the first time on 1.iv.1971 at the age of 3 years and 20 days. This female had remained with adult males throughout this period. Taking the gestation period as 8 months and 7 days (Asdell, loc. cit.) the age of sexual maturity of this female can be said to be not more than 2 years, 4 months and 13 days or say 2 years and 4 months.

Acharjyo & Misra (1971: *J. Bombay nat. Hist. Soc.* **68** (2): 446) have given the age of sexual maturity of one female nilgai as 2 years and 1 month.

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WILD LIFE CONSERVATION OFFICER, R. MISRA
ORISSA, CUTTACK - 1,
July 29, 1972.

7. OCCURRENCE OF THE COMMON GREY HORNBILL (*TOCKUS BIROSTRIS*) IN BOMBAY CITY

On the afternoon of the 7th April 1973 we saw, while on a visit to the wooded environs of the Raj Bhavan at Bombay, a pair of the

Common Grey Hornbill (*Tockus birostris*). The characteristic casque on the beak of the hornbills was clearly visible.

We saw two hornbills actively chasing each other in the trees in the same area again on 13 April. They were joined by a third while we were watching them. We watched them for over ten minutes with a pair of binoculars and there was no doubt about their identity as Common Grey Hornbills, thus confirming the earlier identification of the birds on 7 April 1973.

In their paper on the birds of Bombay and Salsette, Salim Ali & Humayun Abdulali (1940) have not reported on the occurrence of the Common Grey Hornbill in the region. Salim Ali (1964) also states that this hornbill is replaced in the heavy rainfall Western Ghats country north to Bombay by the Malabar Grey Hornbill (*Tockus griseus*) which lacks the casque above the bill. Salim Ali & Ripley (1970) also do not refer to its occurrence in the Bombay region while specifically mentioning the occurrence of the Malabar Grey Hornbill around Bombay.

However, Salim Ali & Abdulali (1945) have recorded the sighting of a Common Grey Hornbill in April 1945 and the present record substantiates the occurrence of this species in an area which has so far been considered more or less exclusively within the range of the allied species *Tockus griseus*, the Malabar Grey Hornbill. These sightings raise some interesting possibilities. Since both sightings are in April, these could be the result of a seasonal movement in search of better forage or a movement brought about by the severe drought this year. We do not know whether 1945 had similar weather conditions. Another possibility is that environmental changes in the Bombay area, has made it suitable for this species. The colonisation of the Bombay area by the species and its effect on the resident population of *Tockus griseus* would be worth investigating.

We wish to thank Mr. J. S. Serrao for assistance in literature reference.

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BOMBAY NATURAL HISTORY SOCIETY, J. C. DANIEL
HORNBILL HOUSE,
BOMBAY 400 001,
April 15, 1973.

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8. ON THE STATUS AND DISTRIBUTION OF THE GREAT GREY SHRIKE, *LANIUS EXCUBITOR* LINNAEUS IN MYSORE

The Great Grey Shrike, *Lanius excubitor* Linnaeus, is not known to occur in southern India south of Belgaum (Mysore) or the Krishna River in Andhra Pradesh and except for a couple of records of this species from Cuddapah district of Andhra Pradesh and a single sighting in Ceylon (Ali & Ripley 1972), nothing is known of its status or distribution in the southern India.

I found this shrike throughout Mysore State all round the year. One or two birds were invariably found in patches of dry, open scrub around Bangalore and were also seen in the open semi-arid country in the Raichur and Dharwar districts of northern Mysore. This shrike has also been observed in the Sandur taluk of Bellary district (Ghorpade, in press). Although the bird has not yet been found breeding, the above observations indicate that it is probably a resident in the Mysore plains, south to Bangalore, inhabiting dry open country, short thorny scrub and similar biotope.

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December 21, 1972.

KUMAR D. GHORPADE

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9. THE JUNGLE CROW, *CORVUS MACRORHYNCHOS* WAGLER, PLUCKING HAIR FROM TAIL OF COW TO LINE NEST

It is a recognised fact that most of the crows (*Corvus* Linnaeus) line their nests with, among other material, mammalian hair (Ali & Ripley 1972; Lamba 1963, 1965). Lamba, in his account of the breeding biology of the Jungle Crow, quotes Hutton who states that 'human, horse or other animal hairs...... are sometimes pulled off the backs of live animals or skins laid out for drying.'

In February 1972, I watched a pair of jungle crows (*Corvus macrorhynchos*) investigating the tail of a cow sitting under a large jack tree on a farm near Bangalore at around 1230 hrs. One of the birds walked up to the bushy black tail tip and started tugging at the hairs. In a few minutes, it had pulled out a beakful of hair and then flew on to its unfinished nest on a nearby *Araucaria* pine. It was plucking out the hairs one by one and was accumulating them at the base of its bill, giving it the ridiculous appearance of sporting a gigantic moustache. I estimated that it had collected at least 30-40 separate strands of hair in the operation. The bird did not return for an additional supply of hair for the next hour. The cow seemed quite unconcerned with the crow and did not attempt to move its tail.

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December 21, 1972.

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10. BAYA (*PLOCEUS PHILIPPINUS*) FEEDING ON FROGS

On 8th May, 1973, while I was trying to collect some larks, I saw two parties of bayas (*Ploceus philippinus*) feeding at two different parts of a large paddyfield at Paddyadikol, Cherpu, Trichur District, Kerala State. In both places, two or more individuals were seen to catch small frogs, which were plentiful in the paddyfield where the rice was being harvested. The frog was caught in the bill, carried to the overhead electric wires, battered to death and swallowed piece by piece. One frog obtained in the field has been identified as *Rana limnocharis.*

I do not know if such food habits have been recorded for the baya.

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PRINCE OF WALES MUSEUM,
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June 27, 1973.

N. J. GEORGE

11. SNAKE BITE CASE HISTORIES

(1) May 24th, 1971. Medavakkam, near Madras.
Girl, 18, suspected krait bite, fatal. Sleeping on a mat on the floor of the hut when bitten on leg. Snake was killed and described as being long, thin and black. Girl was given "country" remedies but died before daybreak.

(2) August 25th, 1971. Tambaram, near Madras.
Gurkha, Nepali night watchman, about 40 years old, suspected krait or cobra bite. At 7 a.m. men came rushing to me to say that this man had been bitten and died but could I somehow help anyway!? (This has happened several times). Watchman stepped on and was bitten at 1 a.m. by an unknown, "large" snake. His wife and he then sat around. By 3 a.m. the man succumbed. No help was sought, till morning.

(3) January, 1972. Boy, 10 years, died possibly as a result of complications from bite of *Echis carinatus.* (*see* case 9, *Echis* bites).

(4) May 26th, 1972. Madavakkam, near Madras. Friday morning—rainy, windy. 8 a.m. two men arrive with news of snake bite at Medavakkam (4 miles away on Velachery Rd.). I reached the hut 8.15 a.m. A crowd of people, mostly women were crying and yelling and beating themselves on the breast in anguish. The young man, of about 22, lay flat on back, arms folded, flower petals on eyelids, only light in the room was an oil lamp. No pupil response, no pulse, heartbeat or breath. The left lower leg quite swollen, with two obvious punctures below ankle bone. An Irla (tribal snake catcher) was digging around the hut trying to find the snake which was supposed to have been called cobra by the bitten man—he saw it crawl away in the moonlight. Possibly krait. It was as likely or more so that it was a krait since it is a common nocturnal prowler and seems less wary than a cobra; these "bites while

sleeping" are common. The sleeping man may have felt the snake brushing against him and in his sleep pressed the snake with his foot (perhaps rolled over it). He woke up, saw the snake which seemed to go into a hole in the hut. Many people woke and carried him to a village 2 miles away for "country medicine", a plaster of green paste supposed to contain the remedy. He came back and sat and was slowly paralyzed to death by the neurotoxins in the venom. Had trouble breathing at 6 a.m. and collapsed at 7 a.m. Just 4 miles away is a dispensary and my home; it is well known that we have antivenom serum. We treated or supplied serum for about 2 dozen bites in the last year (mostly *Echis*). If the use of antivenom was publicized, there would be very few fatal snakebites in India and the public attitude towards snakes could gradually become realistically tolerant. At present a supernatural fear of snakes prevails and no wonder when the venom can kill so surely in spite of all the "remedies" tried out.

(5) 17th August, 1972. Madras City.
Lady, 58 years, suspected krait bite, fatal. At 6 a.m. went into bathroom to take a bath, stepped on 'small black snake about 2 feet'. Local symptons absent, small single wound, little bleeding, slight oozing. In the first 6 hours the blood pressure rose, complained of trouble in swallowing, breathing, 6 hours after bite she went into a coma. 2 vials antivenin given, supportive therapy, antihistamines, blood pressure drugs, haemodialysis. Lady succumbed without coming out of coma next day at 11-30 a.m. (about 36 hours later).

(6) June 2, 1972—Chinnappa—18 year old Irula tribal snake-catcher of Sotalapakkam village near Tambaram, Madras 44, cobra bite, recovered.

The day after a heavy shower Chinnappa was hunting snakes with his uncle. They were hunting in separate farm areas near rocky hills about 18 miles from Madras City. Chinnappa, searching carefully for tracks made out the fresh track of a large snake (he thought cobra) going into a rat hole. Rat holes are everywhere on the earthen and rock mounds and bunds near paddy fields. He dug with a small crow bar and poked with a thin stick down the various branches of the hole. In one the stick moved. He dug forward carefully; he was only about 2 feet deep into the mound when he gradually uncovered a very fine healthy cobra just under 5 feet long. Quickly he pressed the flat side of the little crowbar on the snake's head and grabbed a secure hold on the neck with his left hand. He had a small cloth shopping bag with handles to tie the open end shut. Then he did an odd thing for an experienced snake catcher, "not thinking for a moment": holding the bag open with thumb and forefinger encircled, he pushed the cobra's head into the resultant hole. The cobra partly entered the bag then very quickly turned and bit Chinnappa through the cloth on the fleshy part of the left hand below the little finger with both fangs. He immediately threw the snake down (which was caught in the same mound the next day!) and clutched his left wrist. He walked a little and called to his uncle about half a mile away. His uncle tied a piece of cloth tightly on the upper arm, the hand had already begun swelling. $3\frac{1}{2}$ hours later (4 p.m.) he had walked and ridden on the back of a cycle the 6 or 7 miles to Madras Snake Park. The swelling was halfway up the arm and he complained of much burning pain throughout the arm below the tourniquet. Antivenin was ready and we removed the tourniquet to relieve the pressure on his arm. Until 8 p.m. there was little change except the steadily increasing swelling now above the elbow. At 8.30 p.m. Chinnappa started having the symptoms of drooping eyelids and puffed lips called ptosis, the first sign of systemic neurotoxic poisoning. We immediately drove him to the clinic nearby where the lab tech, supervised by Dr. Sarangapani gave 10cc Haffkine polyvalent antivenin with 5 mg cortisone IV. Shortly afterwards, Chinnappa vomited but looked more lively. We waited at the clinic for an hour and then returned home where Chinnappa, with his old mother watching over started a fitful night. His arm was less painful, most of the pain was at the site of the bite. At about 11 p.m. he started shivering violently so he was covered with blankets and rubbed by mother and cousin. The shivering went away in 20 minutes (maybe allergic reaction to antivenom). Gave two aspirins and he slept well till morning. His arm swelling reached a painful peak and then subsided except for the hand within 12 hours. A ten day supply of multivitamins given. Twelve days later hand is still very swollen, site of bite appears as some skin will slough. Advised daily dressing changes. Thirty days later, bit of skin loss took place but except for stiffness hand and arm are OK, advised exercises for hand.

Bites of *Echis carinatus*

1) Panvel, near Bombay, October, 1967. An adult male Adivasi aged about 35 was bitten in the evening just behind big toe on top of right foot by an *Echis* about 10 inches long. Came next day 2 p.m. for treatment. Dorsum of foot edemal, slight discoloration of site of bite. Blood pressure 100/60, complains of pain, didn't sleep. Slight bleeding from gums. Treated with tetanus toxoid and antibiotics. Next evening (48 hours post bite) gum-bleeding stopped, foot seems more swollen, complains of pain and discomfort. Aspirin and sulfa tablets given. Adivasi plastered jungle medicine that looks like cow dung all over bitten foot. Six days later Iodex applied to bitten limb and patient said swelling went down soon after application. Eight days later foot appears normal, no necrosis or swelling.

2) Deogad, Ratnagiri District, Maharashtra, September, 1969, 7 a.m. N. Gate, a male worker, aged 30 walking to work through a field near Deogad town, stepped on a 300 mm long echis and was bitten on right lateral side of ankle joint on the right foot. The victim walked two miles to the dispensary with a friend's help. Snake was killed and brought in at 8.30 a.m. When the patient reached the doctor there was swelling and tenderness around the site of bite; dark bluish discoloration about 2 inches in diameter. Shooting pain in calf muscle, adenitis behind knee and in lower inguinal glands. Swelling of ankle and foot increasing.

9 a.m. as patient did not exhibit any alarming or systematic symptoms, 10 cc of Haffkine serum was injected intramuscularly. Procaine-pencillin injected, aspirin given and patient sent home.

Next day, 8 a.m. patient reported to doctor that he had recovered; only slight signs remained at the site of bite.

3) Jamsande, Ratnagiri Dist., 15 January, 1963, a.m. S. S. Bhadsabe, a male worker age 25 years was moving stones and got a toe bite from an echis. Within one hour he came to dispensary with severe local bite symptoms. Urine cloudy and bloody. 15 cc Haffkine antivenom given intravenously which provoked immediate allergic reaction including: urticaria, severe itching, heat, headache, asthmatic breathing. Administered .5 cc adrenalin and treated patient for shock for half an hour. Additional 5 ml antivenom given. Calcium lactate given. Next day local symptoms diminished, urine trace blood; calcium gluconate and calcium lactate given. Third day patient seemed completely recovered, calcium lactate given.

4) Deogad, Ratnagiri Dist., 27 January, 1965 a.m. A. G. Kawale, a 1½ year old male child was playing in the garden and picked up an echis which he mistook for a rope. He was bitten on the right palm and there was swelling at site of bite and whole of palm within half an hour. The child's crying attracted attention and he was brought to the doctor within 45 minutes after the bite. 10 cc Haffkine antivenom injected intramuscularly in the buttocks one hour after bite. 20 grains calcium gluconate given. Local symptoms subsided by evening of the same day, recovery complete.

5) Deogad, Ratnagiri Dist., August, 1964 a.m. Female age 65 was bitten on the instep of left foot by an echis and came to dispensary within one hour. 10 cc Haffkin antivenom was given intramuscularly as local symptoms of swelling and pain were apparent. After five hours there was bleeding from gums and evidence of blood in stools. An additional 10 cc serum was injected intravenously. The patient had moderate allergic reaction which was treated and patient recovered but weak after 6 hours. Second day recovery complete.

6) Sembakkam, near Madras, October 20, 1970. A male child about 10 years, was bitten the evening before by an echis on the big toe while going out to the bathroom. When he came at 10 a.m. foot was moderately swollen and slight swelling of the lower leg. Little pain, weakness and discomfort evident. Taken to a nearby doctor where he was observed for a few hours treated locally and sent home with instructions to parents to look for bleeding gums etc. Swelling subsided within 2 days and there were no after effects.

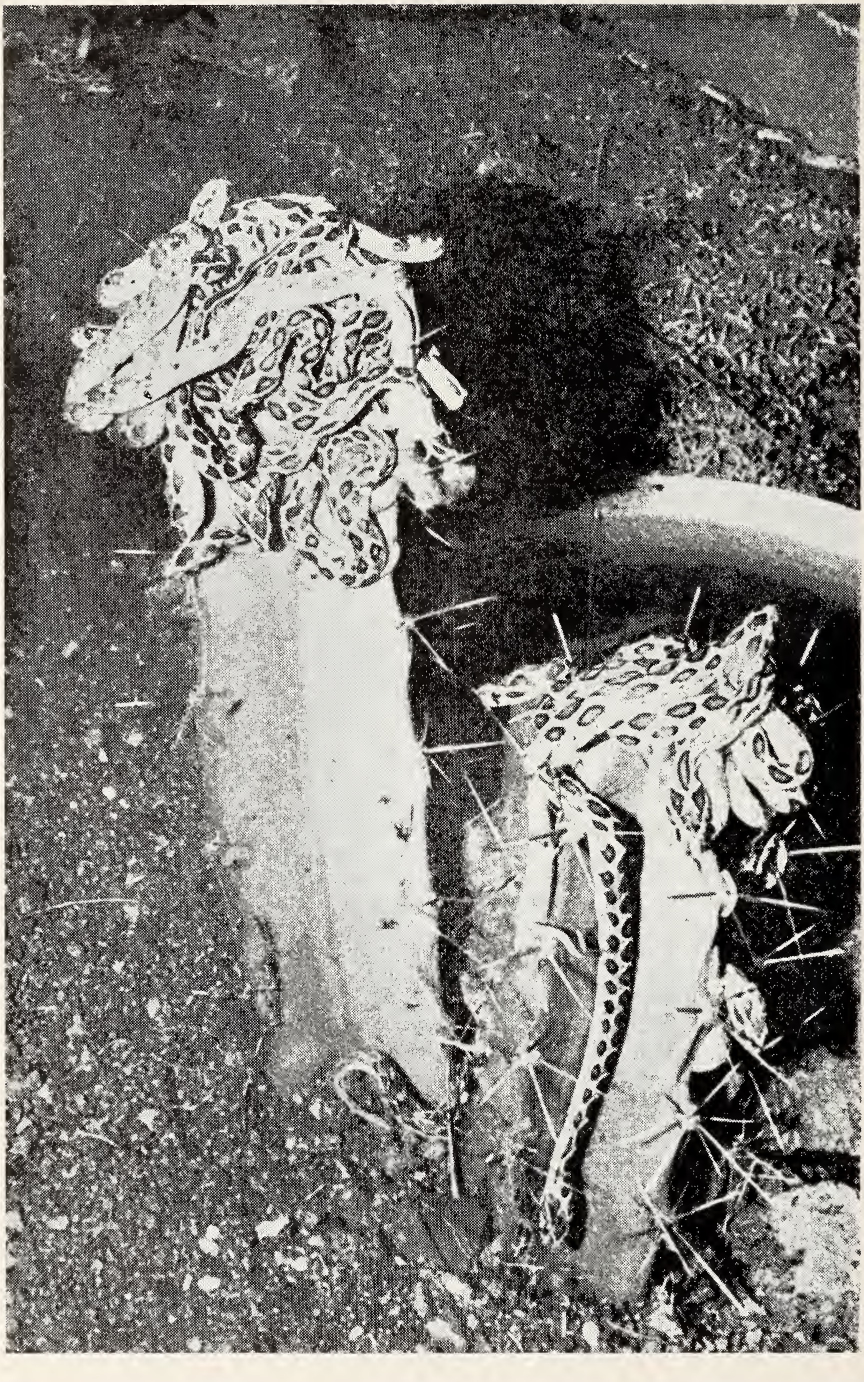
7) Sembakkam, near Madras, November 17, 1970. A woman about 40 years old was bitten by an echis while cutting branches from a low thorn tree. Finger was tied tightly with a string and was tautly swollen. I released the string. The patient exhibited great pain and anxiety. Took her to doctor where she was kept for observation that afternoon then sent home. In two days there was a little tissue loss and dressings were applied. Swelling and sloughing persisted a week.

8) Tambaram, near Madras, December 15, 1970. An Irula snake-catcher, was bitten by an echis on the right thumb while catching it. Didn't suffer on the first day. Second day had swollen hand and for 2 days had difficulty using hand. Untreated and no more symptoms.

9) Tambaram, near Madras, November 25, 1970. Natesan, an Irula snake catcher about 40 bitten on base of left index finger while catching. Swelling slight, stiff hand for two days, pain only for first hour or so. No other symptoms, complete recovery without treatment.

10) Sembakkam, near Madras, September, 1971. Boy about 10 years bitten on foot in evening near home by echis. Two hours later when he arrived at my house leg was greatly swollen and boy very frightened, near collapse. No evidence of systemic poisoning. Gave local treatment, observed for a few hours then told them to go home unless something like bleeding gums occurred. One month later the father came to say that the swelling still hadn't gone down though they had seen doctors. In January, four months later the boy died, cause unknown but the father feels it's the same snake bite. (?)

11) Sembakkam, near Madras, July, 1971. Adult male 35 years bitten by echis on right foot at night while walking on road. Arrived at our house 8 a.m. foot and lower leg greatly swollen and bleeding profusely from gums. Otherwise he was feeling all right and normal. I gave him 2 vials of serum to take to the nearby doctor and asked him to check with me later. Few days later he came back with still swollen leg and asked what to do. I advised soaking in salts and seeing a doctor. In April 1972, 8 months later, this man came obviously in great discomfort with his foot still swollen. It seems that the lymphatic and general circulatory congestion so common in viper bites can persist for a long time and cause permanent defects.



A group of small vipers perched above the wet ground after a night rain.

(*Photo*: *Madras Snake Park Trust*)

I am most grateful to Dr. Nene, Deogad for cases 2-5 and to my sister, Nina Chattopadhyaya for helping with most of the other cases.

The following notes were given to me in an interview by Dr. B. Bapiraju, presently working at King Institute, Guindy, Madras.

During the years 1963 to 1965 Dr. Bapiraju practiced medicine at the medical station in the town of Panjapatti, 30 miles from Trichy. During this two year period 40 to 50 cases of snake bite came to hospital for treatment. 60 to 70 per cent occurred at night and over 95 per cent were on the feet, a small per cent on legs, hands and arms. Most bites appeared to be from *Echis carinatus* which abounds in that area.

Patients arrived usually within a few hours of the bite; in this area the villagers are aware of the effectiveness of antivenom due to the work of the doctors. There was swelling of the limb and pain, often severe, at the site of bite. Some cases complained of severe pain in pharyngeal region. Bleeding gums not noticed. Blood in vomit in a few cases, bloody urine in 70 per cent of cases.

Treatment was by Haffkine polyvalent antivenom serum, intravenously when serious, intramuscularly when not severe. Antivenom preceded by adrenalin and cortisone. Two or three cases of anaphylaxis from sensitivity to serum. Most patients vomit within 15 minutes after receiving serum intravenously. There were no fatalities or after effects like necrosis or prolonged swelling or permanent stiffness.

The south Indian *Echis carinatus* only average 10 or 12 inches in length thus making it too small to be of great medical significance for which the big northern race is notorious.

MADRAS SNAKE PARK, R. WHITAKER
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November, 1972.

12. CLIMBING RESPONSE OF TWO SNAKE SPECIES DURING RAIN. (*ECHIS CARINATUS* AND *VIPERA RUSSELLII*)

(*With a plate*)

Thirty adult saw-scaled vipers and forty-eight juvenile Russell's vipers were kept in a smooth sided concrete pit 4′ × 8′ × 4′ with grass, rocks, shrubs and cacti during 1972. During nocturnal rain showers in August and subsequent months it was noticed that rain stimulates a climbing urge in these snakes. Sometimes a mixed mass of twenty snakes could be observed on the top of one cactus or small shrub. The Irula tribals already know this as they systematically collect Echis in shrubs and behind tree bark during the wet part of the year.

It is often noticed that humidity alone causes a dramatic increase in reptile activity in general. Some snake species are especially active during heavy rain, the hole dwelling and smaller forms perhaps because of the direct flooding action of the rain. Cobras (and other species notably susceptible to cold) spend much of their time in trees during the cold, rainy part of the year in south-eastern India.

Madras Snake Park, R. WHITAKER
Guindy Deer Sanctuary,
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January 29, 1973.

13. COLOUR VARIATION IN RUSSELL'S VIPER (*VIPERA R. RUSSELLII*)

(*With a plate*)

Russell's vipers from the Indian sub-continent and Ceylon are fairly uniform in colour. The exception is the geographic race from the northern part of the western ghats in Maharashtra.

The typical Indian Russell's viper is light brown above with brown, black and white ringed oval spots dorsally. The Maharashtra form is a light yellowish brown snake with almost completely uniform dark spots with only a suggestion of the white ring. The underside is uniformly yellowish white. The Madras form is brightly marked with occasional black markings ventrally. Those from the Calcutta area are similar to the Madras colour form but darker and always with black spots ventrally.

Madras Snake Park, R. WHITAKER
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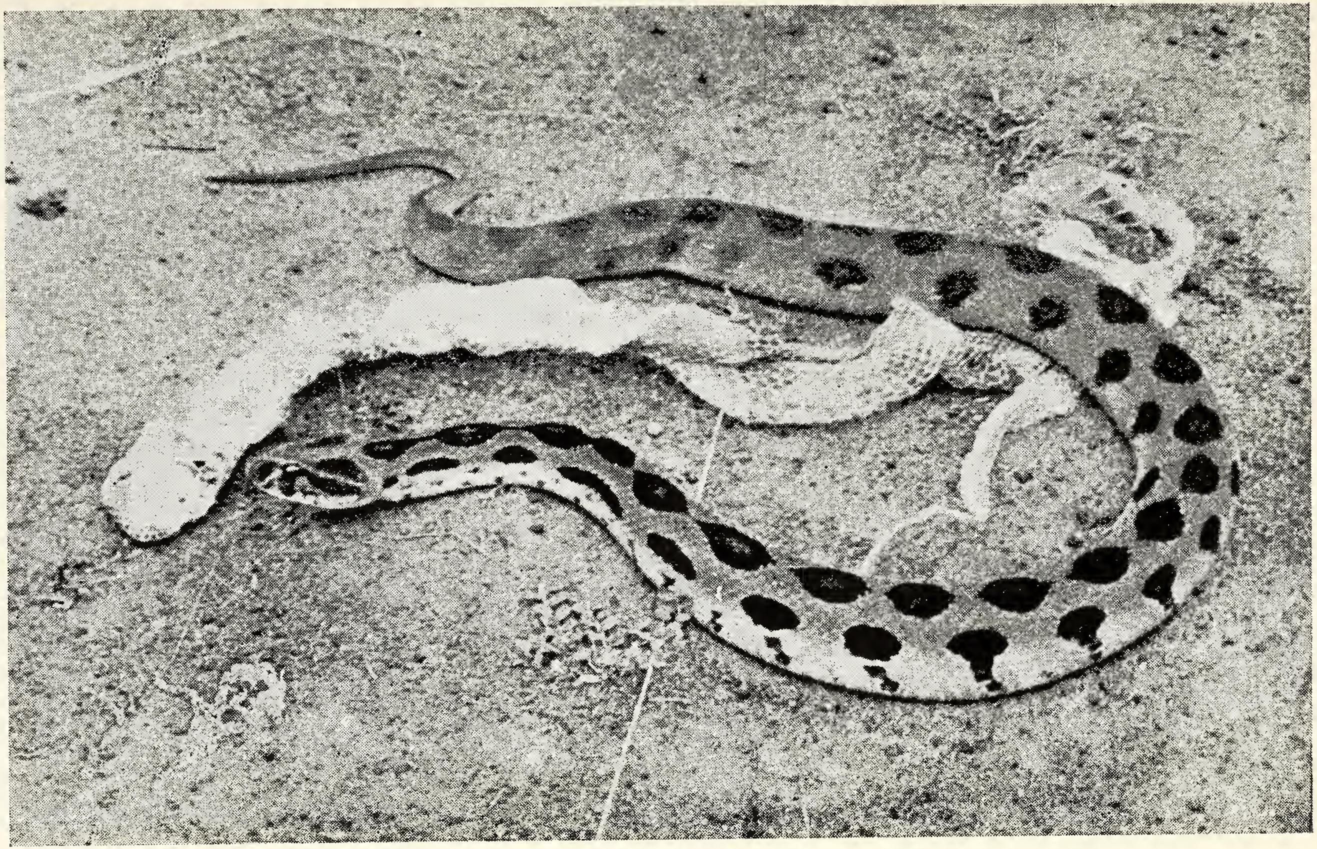
Madrass 600 022,
March 29, 1973.

14. ON THE SEXUAL DIMORPHISM OF A SILUROID FISH, *OMPOK BIMACULATUS* (BLOCH), WITH PARTICULAR REFERENCE TO PECTORAL SPINE

While handling large numbers of specimens of *Ompok bimaculatus* (Bloch) in the laboratory and in the field in connection with investigations on its biology in Kulgarhi reservior (MP) some disparity was observed in the dentition pattern, size and stiffness of the pectoral spines of males and females. The genital papilla was also observed to

Whitaker: Russell's Viper



Vipera russellii russellii from Maharashtra with typical solid dark dorsal spots, fading at the tail.

be present in both of the sexes but with marked difference in their morphological characters during breeding season. Day (1889) observed female specimens of *Ompok bimaculatus* at Trichinopoly having entire (i.e. smooth) pectoral spines. He stated that the character of pectoral spine whether smooth or serrated is not a specific distinction. While giving the systematic account of *Ompok bimaculatus*, Parameswaran *et al.* (1967) have reported 'pectorals with a strong internally serrated spine in males, and entire or feebly serrated in females'. The validity of sexual dimorphism on the basis of pectoral spine and genital papilla has been established in the present study by examining 600 specimens of *Ompok bimaculatus* (size range 172-394 mm) spread over one year. The sex determination was first attempted with the aid of pectoral spine and genital papilla and then confirmed by gross examination of the gonads. The detailed observations made on the sexual dimorphism of this species on the basis of these characters are reported in the present note.

In the initial stages of observations, the male and female specimens of comparable sizes were selected to differentiate the sex on the basis of pectoral spine and genital papilla. Observation on the pectoral spine and genital papilla of both sexes were also made monthwise throughout the year to elucidate whether the differences were seasonal or of permanent nature. These observations showed that the variation in the dentition pattern, size and stiffness of the pectoral spines in males and females was valid as a secondary sexual character and a permanent feature throughout the year, whereas the variations in the morphological characters of genital papilla of the two sexes were prevalent during breeding season only.

The significant difference in the pectoral spine and genital papilla in the two sexes are enumerated below:—

Distinguishing characters of Pectoral spine

	Male	Female
1)	Strong and Hard.	Weak and flexible.
2)	Laterally flattened, broad and somewhat thick along the entire length.	Thin and narrow along the entire length.
3)	Abruptly tapering into blunt spine.	Gradually tapering into sharp spine.
4)	Inner edge of the spine with strong and prominent serrations.	Inner edge of the spine feebly serrated or nearly smooth.

Genital papilla:—

It lies behind the vent in both the sexes. In the case of male, it appears as a small outgrowth, whereas in females it is somewhat fleshy and comparatively larger in size, almost double the size of that of male. In male it is visible during the breeding season only.

The field observations have confirmed that with the aid of these contrasting differences it is possible to segregate the sexes irrespective of the size of the fish, throughout th year with good accuracy and more so during the breeding season.

ACKNOWLEDGEMENTS

We are greatly indebted to Dr. V. G. Jhingran, Director and Dr. Y. R. Tripathi, Deputy Director, of the Institute for kindly going through the manuscript and for valuable suggestions.

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15. ON *CHRIONEMA CHRYSERES* GILBERT, A RARE BATHYPELAGIC FISH IN THE INDIAN OCEAN

(*With a text-figure*)

Gilbert (1905) established the genus *Chrionema* for two new bathypelagic fishes from the Pacific Ocean: *C. chryseres* and *C. squamiceps.* Fowler (1928) synoymised these two species as he considered the latter as the juvenile of the former species. In a revision of the family Percophididae, Ginsburg (1955), however, recognises *squamiceps* as a valid species based on a study of the types but considered the species congeneric with *Chriomystax squamentum* Ginsburg, 1955 and restricted the genus *Chrionema* to its type species.

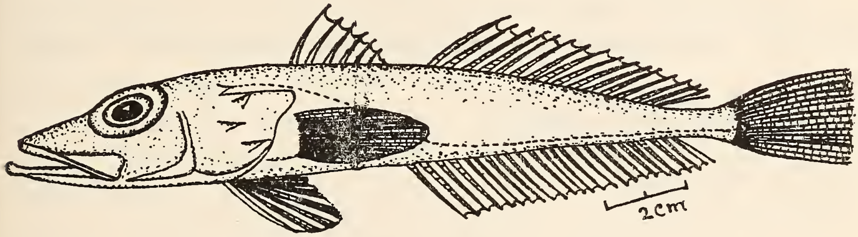
During a recent faunistic survey of the south-west coast of India, a specimen of *Chrionema chryseres* Gilbert, was captured along with numerous other deep-water fishes in an otter trawl from a depth of 300 metres at a station about 85 km off Quilon by the ship "Blue Fin" of the Central Institute of Fisheries Operatives, Cochin. This communication is the first record of this rare bathypelagic fish since its original discovery from the Pacific Ocean off the Hawaiian Islands and adds an interesting species to the fish fauna of India. A description of the single specimen collected is given below.

Chrionema chryseres Gilbert

Chrionema chryseres Gilbert, 1905, *Bull. U.S. Fish. Comm.*, **23**(2): 645, pl. 85 (type loc: Off Oahu, Hawaiian Islands); Fowler, 1928, *Mem. Bernice P. Bishop Mus.*, **10:** 423 (after Gilbert); Ginsbarg, 1955, *Proc. U.S. nat. Mus.*, **104** (3347): 629 (name only).

Material:

One ex., 173 mm in standard length, off Quilon (Kerala) at station Lat. 09° N. Long. 76° E., 300 metres depth, 3 March 1971, *coll.* P. K. Talwar; ZSI Regd. No. F 6310/2.



Chrionema chryseres Gilbert, 200 mm.

Description:

B 7; D VI. 16; A 24; P 24; V 6

Scales in lateral series 76, transverse 12/6.

Gillrakers on first arch 4 + 14; upper arm with one and lower arm with 3 low tubercles.

Body elongate, slender, depth 14.5 in per cent of standard length. Head and anterior part of body depressed, head length 39.3 in per-cent of standard length. Mouth rather large, horizontal, superior, lower jaw extending beyond upper; maxillary extending to vertical from half eye diameter, distal end without fleshy tentacle, length 38.7 in per cent of head length. Eye diameter 24.8, inter-orbital width 4.4; both in per cent of head length. Snout notably depressed, somewhat duck-like, slightly shorter than eye diameter, twice in postorbital distance.

Teeth—villiform bands in jaws, vomer and palatines; tongue edendate.

Scales—ctenoid on body and head; snout, maxilla and space between mandibular rami naked. Pectoral and caudal fin bases scaled, dorsal and anal fin bases scaleless.

Fins—Dorsal fin spines flexible; second dorsal fin similar to anal fin, rays notably well placed. Pelvic fin origin in advance of pectoral fin, under vertical from preopercular margin. Caudal fin truncate with 13 principal rays.

Colour in alcohol—Dark brown above, lower surface creamy. Four large dusky blotches along the sides slightly low and smaller dark blotches in interspaces. Inner rays of pelvic fin dusky, outer two rays and spine creamy white.

Distribution: Hawaiian Islands and the south-west coast of India; bathypelagic.

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I am grateful to Dr. A. P. Kapur, Director, for encouragement and Dr. A. G. K. Menon, Superintending Zoologist, Zoological Survey of India, Calcutta for kindly reading through the manuscript critically.

ZOOLOGICAL SURVEY OF INDIA,
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CALCUTTA - 13,
October 16, 1972.

P. K. TALWAR

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16. *DIODON HOLACANTHUS* LINNAEUS (PISCES: DIODONTIDAE) FROM INDIA

Fishes belonging to the genus *Diodon* (Family: Diodontidae), popularly known as porcupine fishes inhabit coral lagoons of warm oceans. Linnaeus (1758) described *Diodon holacanthus* from India and the species has subsequently been recorded from several parts of the Indo-West Pacific (Herre 1953; Smith 1961; Anon 1962) but surprisingly not rediscovered from India. During a collection tour four topotypes of *D. holacanthus* were collected from Trivandrum (South-west coast of India) and are described below.

Diodon holacanthus Linnaeus

Diodon holacanthus Linnaeus, 1758, Syst. Nat. 10th Ed. 335 (India).
Diodon maculatus var. a, Gunther, 1870, Cat. Fish. Brit. Mus., *8*:307.
Diodon holacanthus Anon, 1962, Fish species of South China Sea: 1100-1102 (China).

Material examined:

4 fishes, 143-161 mm S.L. *ex* Trivandrum (16:9:1968).

Description:

D13, P21-22, A13, C8-9. Gill-rakers on first arch outer 2+7; inner 0+10.

In percentages of standard length; body depth 26.5-41.0, head length 39.2-43.1, snout length 13.5-16.6, eye diameter 9.2-10.8, postorbital length 18.9-22.7, interorbital width 25.0-34.4, caudal peduncle depth 5.4-6.0, dorsal height 15.7-18.1, anal length 15.7-23.2, pectoral length 17.1-21.5, caudal length 15.7-20.4, height of longest spine in first row 17.8-22.4, height of shortest spine in first row 16.4-18.9, pre-dorsal distance 72.1-84.8, pre-anal distance 72.8-84.4, width of mouth 13.6-14.7.

Body covered with numerous spines, spines on forehead commencing with level of front border of eye. First transverse row of four spines on forehead longest, on dorsal and ventral sides shortest, on flanks and behind pectorals longer than the latter. Thirteen spines from forehead to the origin of dorsal fin. Origin of pectoral behind gill opening, middle rays shorter. Origin of dorsal nearer to caudal. Origin of anal below origin of dorsal.

Colour. Ground colour generally brown on dorsal side becoming pale yellow or white towards ventral side, broad blackish-brown band between the orbits, interrupted in middle, extending downwards beyond eye; behind this parallel transverse band not descending downwards. Large subtriangular or nearly irregular spot in the middle of back; similar spot on and in advance of the base of dorsal fin. Kidney shaped spot above the pectoral.

ACKNOWLEDGEMENTS

Messrs S. Rama Rao and K. Varahala Raju of this department rendered valuable assistance during investigations. I am indebted to Dr. Yoichi Shojima, Seikai Regional Fisheries Research Laboratory, Nagasaki, Japan, for his help in the identification of species. I am thankful to Professor G. P. Sharma and Dr. K. K. Tandon, Zoology Department, Punjab University, for critically going through the manuscript.

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December 18, 1971.

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17. MOLLUSCS OF ECONOMIC VALUE FROM GREAT NICOBAR ISLAND[1]

(*With a map*)

During a scientific expedition to the Great Nicobar Island in February-May, 1966, the Zoological Survey of India team surveyed, the littoral, sub-littoral and offshore zones to assess the potential molluscan resources of these areas for exploitation. Fairly extensive shell beds of living and dead molluscs were found in these areas. The species of molluscs of economic value classified under three main categories, namely (i) as a source of food (ii) of ornamental value and (iii) as raw material for manufacture of lime and cement are listed here together with remarks as to their occurrence in and around the island.

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[1] This paper was presented at the "Seminar on the achievements of the Scientific Expedition to the Great Nicobar Island" organised by the National Institute of Sciences of India at Varanasi on 2nd January, 1968.

(i) *Molluscs as a source of food* :

The bivalve *Cyrena galatheae* Morch was found in abundance in all the major rivers of the island *i.e.* the Galathea River on the south coast, the Rivers Alexandra, Dogmar and Amrit Kaur on the west coast and the River Jubilee on the north coast (see map). The Nicobarese and Shompens are aware of its food value. They particularly consume this mollusc during the monsoon when the sea is very rough. They utilize the empty shell for scraping the pulp of steamed *Pandanus* which is one of the regular items of their diet.

The large edible clams, *Tridacna crocea* Lamarck and *Hippopus hippopus* (Linnaeus) were found abundantly in the inshore regions amidst coral reefs around the island. The different bays on the West Coast were rich with *Tridacna crocea* Lamarck in the 4-6 metres depth. Farther deep, between 30-50 metres, both the species occurred in considerable numbers on the eastern side off Galathea bay.

According to Rao (1951), in the Indian mainland, "......species of *Tridacna* from the reefs,...... from the littoral zones are...... occasionally used as food whenever they occur in large numbers". Though our team did not observe the local people utilizing these bivalves for food, it would be worthwhile to exploit them either for direct use for people in the mainland or for processing them for export.

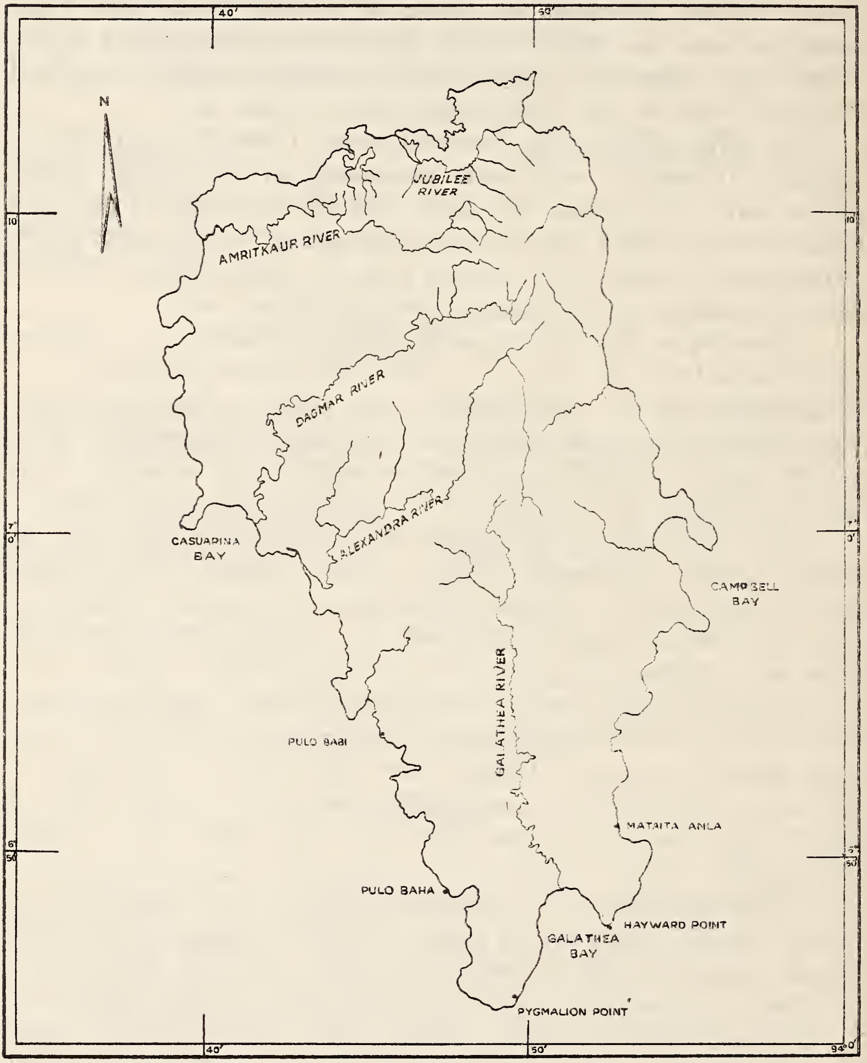
There were also numerous beds of the smaller bivalves such as *Donax cuneatus* (Linnaeus), *Donax lubricus* Hanley and the backwater clam *Meretrix attenuata* (Dunker) in the sandy patches between the littoral fringes at Campbell bay, Galathea bay and Casuarina bay. Detailed investgations may well reveal more extensive beds in several other places around the island. The two species of *Donax* were found along the coast adjacent to the mouths of rivers and creeks, while *Meretrix attenuata* (Dunker) was found right in the mouths of the rivers where there is considerable lowering of salinity. Hornell (1917) and Rao (1951) have dealt with the edible value of these three species.

The bivalve, *Pinna vexillum* Born was seen in the deeper inshore regions (10-20 metres) amidst coral reefs off the western coast of the Island, particularly off Pulobabi (see map). Although no one eats it in India, it is in great demand in Japan and China (Hornell 1917).

The cephalopod, *Octopus cyaneus* Gray frequents inshore coral reef regions of the island in large numbers. It is captured commonly by the coastal Nicobarese who seem to relish its meat.

Beds of the gastropod, *Oliva ispidula* Linnaeus were found at several sandy location sites along with cake urchins (Irregular Echinoids) at the mid-littoral fringe of the island and an extensive bed was encountered at Casuarina bay. The Scorpion-shell *Lambis lambis* Linnaeus was found in smaller patches in the infralittoral region of the inshore waters among coral reefs all around the island, and in greater concentration at 4-6 metres depth between Pygmalion point and Pulobaha and between Hayward point and Mataita Anla. *Lambis chiragra* Linnaeus was also found in Galathea bay but not in such large numbers. In addition to their food value which is sufficiently well stressed by Hornell (1917) and Rao (1951) the two species of *Lambis* are also commonly used as weights for fish nets in the mainland. These molluscs could be exploited to form subsistence fisheries of local importance.

MAP OF GREAT NICOBAR ISLAND SHOWING LOCALITIES OF COLLECTIONS


40'
50'
N
10
10
JUBILEE RIVER
AMRITKAUR RIVER
DAGMAR RIVER
ALEXANDRA RIVER
7° 0'
7° 0'
CASUARINA BAY
CAMPBELL BAY
GALATHEA RIVER
PULO BABI
MATAITA ANLA
6° 50'
6° 50'
PULO BAHA
HAYWARD POINT
GALATHEA BAY
PYGMALION POINT
40'
50'
94° 0'

(ii) *Molluscs of Ornamental Value* :

Dry shells of *Nautilus pompilus* Linnaeus were found washed all along the shore in considerable numbers. Nicobarese use them to bale out water seeping into their canoes.

Trochus niloticus Linnaeus (Top shell) and *Turbo marmoratus* Linnaeus (Turban shell) were found abundantly all along the off shore regions of the entire coast of the island. On the eastern side of the Galathea bay, they were in greater concentrations as evidenced by many specimens brought up by divers. Also, the inshore regions of the different bays on the west coast abounded with the smaller-sized individuals a depth of 4-6 metres. They were also detected at similar depths between Pygmalion point and Pulobaha and between Hayward point and Mataita Anla, where *Lambis lambis* Linnaeus also was found in appreciable numbers (*vide* supra). Nautilus shells are used in the manufacture of lamp-shades, buttons and decorative pieces such as ash-trays, and cameos and for inlay work.

(iii) *Molluscs as raw material for the manufacture of Lime and Cement*

The shells of the following molluscs occurring here can rank as an important source of lime: *Trochus niloticus* Linnaeus, *Trochus radiatus* (Gmelin), *Telescopium telescopium* Linnaeus, *Lambis lambis* Linnaeus, *Lambis chiragra* Linnaeus, *Oliva ispidula* Linnaeus, *Crassostrea madrasensis* Preston, *Ostrea cucullata* Born, *Cyrena galatheae* Morch, *Tridacna crocea* Lamarck, *Hippopus hippopus* (Linnaeus), *Meretrix attenuata* (Dunker), *Donax cuneatus* (Linnaeus) and *Donax lubricus* Hanley.

Although Comber (1905), Hornell (1917), Rai (1932) and Rao (1951 & 1958) stressed that the rich molluscan fauna available around the Indian mainland can possibly supplement the animal protein food supply to the people, not much progress had been made towards its proper exploitation. Even in 1962, the condition appears to have remained practically the same necessitating the remark that, "Molluscan fisheries of India are insignificant as compared to those of the true fish; they, however, play a considerable role in the economy of fishermen and other coastal people who depend upon them for food when fish is scarce or not within their means" (cf. WEALTH OF INDIA—Raw materials, vol. iv. *supplement—Fish and Fisheries*—C.S.I.R., Delhi, 1962, p. 124).

The problem has received greater attention only very recently. In 1968, the status of the different molluscan fisheries of India and their potential has been discussed by Jones (*vide, Abstracts of papers on Symposium of Mollusca*—1968) and a detailed account of Molluscs in Indian tradition and economy has been given by Mukundan (*vide,* *Souvenir, Symposium on Mollusca*—1968). Further, two important resolutions (3 and 8) have been unanimously adopted at the symposium on Mollusca held at Ernakulam in January, 1968, which focus the attention on the urgent need to conduct surveys in developing countries to enable optimum utilization of their molluscan food resources and recommend steps to popularise the utilization of molluscan shellfish hitherto utilized only by the poorer classes of people.

The species recorded here are not exhaustive as the survey was brief. Therefore, detailed investigation extending over longer periods are necessary for a fuller understanding and estimation of the resources and for determining the possibility of their sustained exploitation.

ACKNOWLEDGEMENTS

We are thankful to Dr. A. P. Kapur, Director, Zoological Survey of India, for facilities to undertake this work; to Shri C. Karunakaran, Deputy Director-General, Geological Survey of India—leader of the expedition for facilities provided during the expedition. Thanks are also due to the various members of the Zoological Survey of India team for helping in the survey.

ZOOLOGICAL SURVEY OF INDIA,
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18. OCCURRENCE OF *LIMA (LIMARIA) FRAGILIS* GMELIN (MOLLUSCA: PELECYPODA) IN THE COASTAL WATERS OF RATNAGIRI

Live specimens of *Lima* (*Limaria*) *fragilis,* are available mostly from August to December, in the intertidal zone of Mirkarwada and Jaki-Mirya in Ratnagiri. Some specimens were kept alive in laboratory aquaria for about four months. The beautiful reddish pink colour of the animals started fading after four to six days and finally they became uniformly pale. Several attempts to feed them in captivity failed. After two to three weeks, they started building a nest from byssus threads. During this period of nest building they were left undisturbed. Once the nest was complete they stayed within the nest. The nest had an opening at either end. Water entered through one opening and came out through the other.

Members of the family Limidae are known for their beautiful coloration and capacity to swim. So far, *Lima* (*Lima*) *lima* Linn., *Lima* (*Lima*) *annulata* Lammark, *Lima* (*Lima*) *lischkei* Lamy, and *Lima* (*Limaria*) *fragilis* Gmelin have been recorded from the Indian ocean.

Of these the first two are widely distributed in the Indo-Pacific region, whereas the third species is recorded from Japan and Philippines in the Pacific to Mauritius in the Indian Ocean. *Lima* (*Limaria*) *fragilis* Gmelin is distributed throughout the western pacific (except Japan and Hawaii), Australia, East Indies, Bay of Bengal, Cocos Keeling and Maldive islands, (Dr. Abbotts, personal communication). Maldive appears to be the westernmost limit for this species in the Indo-Pacific area. Occurrence of this species at Ratnagiri extends its distribution slightly northwards in the Arabian Sea.

The records of *Lima* sp. from Indian coastal waters are few. This is the first record of *Lima fragilis* from the west coast.

We are indebted to Dr. R. Tucker Abbott for identifying the species.

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19. PROBABLE TRANSPORTATION OF *BALANUS AMPHITRITE STUTSBURI* (DARWIN) BY SHIPS

Occurrence of *Balanus amphitrite* var. *stutsburi* Darwin, has been reported from three widely separated localities along the west coast of India (Wagh & Bal 1969). According to Stubbings (1961) distribution of this variety is restricted to the west coast of Africa and is reported to be found especially in estuarine environments (Sandison 1966). In India also, localities from where these forms were collected are situated near the openings of river-mouths and possess somewhat similar ecological conditions. It was, therefore, expected that this variety may be found at other localities on the west coast having apparently same environmental conditions. However, it could not be found at any other place along the Konkan and Goa coasts of western India (personal observation).

This anomaly in distribution can be explained by suggesting that these barnacles might have been transported to the west coast of India by certain agency which could restrict their transportation to selected localities only. A possibility of their being transported through water-currents cannot be entertained because in that case their distribution would not be restricted to a few localities. Hence, the only alternative explanation that can be advanced is the possibility of these forms which belong to the category of fouling ones (Darwin 1854) settling on ships as fouling organisms and being brought to the Indian ports. In this way occurrence of these barnacles only at selected localities can be explained. The stations where these specimens were collected are known to have maritime connections with the west African coast since centuries. This explanation is further supported by the similar phenomenon in which forms of *Elminius modestus* (Darwin) have been reportedly transported from the Australian coast to Europe (Bishop 1951).

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ARUN B. WAGH

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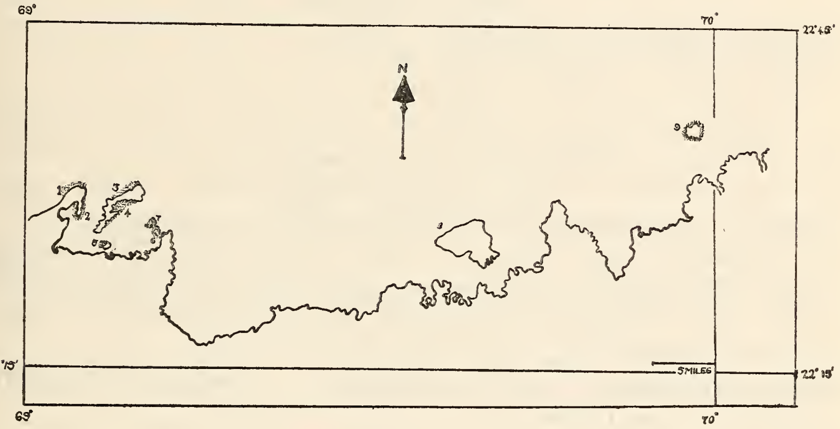
20. NEW RECORDS OF BRACHYURAN DECAPODS FROM THE GULF OF KUTCH

(*With a map*)

Earlier reports of the Brachyuran fauna from the Gulf of Kutch were those of Alcock (1900), Hornell and Southwell (1909), Gideon *et al.* (1956), Chhapgar (1957) and Chandy (1969). The present account is based on a collection of 49 species of which 19 have been reported new from this area. The material was collected during 1966-69, from the intertidal areas, of Okha reef, Adatra reef, Beytbalapur, Hanumandandi, Keu Island, Poshitra, Pirotan Island and Karumbhar Island (see map), using trawls and dredges.



Map of Gulf of Kutch showing areas of collection. 1. Okha reef. 2. Adatra reef. 3. Hanumandandi. 4. Beytbalapur. 5. Keu Island. 6. Poshitra. 7. Dona reef. 8. Karumbhar Island. 9. Pirotan Island.

A systematic list of these species is given below along with the localities of collection. The classification is based on Alcock's "Materials for Carcinological fauna of India" (1895).

Family: CALAPPIDAE

Calappa lophos (Herbst)—Okha reef, Pirotan Is.
Matuta planipes Fabricius—Pirotan Is.

Family: LEUCOSIDAE

Parificulus rostratus Alcock—off Pirotan Is.

Family: HYMENOSOMIDAE

Doclea gracillipes Stimpson—off Pirotan Is.
Schizophrys aspera (Milne-Edwards)—off Karumbhar.

Family: PORTUNIDAE

Scylla serrata (Forskal)—Hanumandandi.
Neptunus pelagicus (Linnaeus) Hanumandandi, Adatra reef.
Charybdis (*Goniosoma*) *natator* (Herbst)—Okha reef.
Charybdis (*Goniosoma*) *annulata* (Fabricius)—Hanumandani, Okha reef.
Charybdis (*Goniosoma*) *callianasa* (Herbst)—Pirotan Is.
Charybdis (*Goniosoma*) *orientalis* (Dana)—Dona reef.

Family: XANTHIDAE

Xantho (*Lophoxanthus*) *scaberrimus baccalipes* Alcock—Adatra reef.
Leptodius exaratus (Milne-Edwards)—Okha reef.
Galene bispinosa (Herbst)—off Karumbhar.

Family: GONEOPLACIDAE

Eucrate crenata dentata (Stimpson)—Keu Is.
Litocheira angustifrons Alcock—Beytbalapur.

Family: OCYPODIDAE

Gelasimus dussumieri Milne-Edwards—Poshitra.
Sesarma quadrata (Fabricius)—Okha reef.
Sesarma oceanica de Man—Hanumandandi.

I wish to express my grateful thanks to Mr. K. V. Navathe, Director of Fisheries, Gujarat State, for the facilities given for this work. I am also indebted to the Director, Zoological Survey of India, who helped in confirming the identification of some of the species; to Mr. M. Bhaskaran, Asstt. Research Officer, Marine Biological Research Station, Okha for the encouragement given in the course of this study, and to M/s P. Gopalakrishnan and P. Sharma for assisting in collecting the material.

MARINE BIOLOGICAL RESEARCH STATION, MOHAN CHANDY
GOVERNMENT OF GUJARAT,
OKHA,
March 11, 1970.

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21. NEW RECORDS OF ODONATA FROM NORTH-WEST INDIA

Dragonfly fauna of north-west India is very inadequately known. Except for the reports of Singh and Baijal (1954), Mani *et al.* (1955) and Singh *et al.* (1955) on the Odonata collected from north-west Himalayas; and by Sahni (1965 & 1965a) on the Odonata of district Nainital (U.P.), no serious attempt has been made to study these interesting insects from this region.

Working on the collection of Odonata from Garhwal and Siwalik Hills we came across several species which have not been recorded from this region so far. These species are fairly common in this region and can be collected without much effort. Records of these species from this have considerably extended the known distribution of these species as given by Fraser (1933, 1934 & 1936).

Following is the list of species, arranged systematically, recorded for the first time from north-west India.

Suborder Zygoptera

Family Coenagriidae

Lestes viridula Rambur

Known distribution: Peninsular India especially Deccan and west India.

New Records: Kangra (Himachal Pradesh) and Dehra Dun (U.P.)

Drepanosticta carmichaeli Laidlaw

Known distribution: Sikkim, Kalimpong and Pashoke.

New records: Chamoli, Dehra Dun, Pauri Garhwal, Tehri and Uttarkashi (U.P.).

Calicnemis pulverulans Selys

Known distribution: North Bengal and Sikkim.

New records: Uttarkashi and Tehri (U.P.).

Calicnemis miles Laidlaw

Known distribution: Upper Burma (Gokteik), Sikkim.

New records: Chamoli, Pauri Garhwal, Uttarkashi, Dehra Dun, Tehri (U.P.) and Kangra (H.P.).

Copera marginipes (Rambur)

Known distribution: Lower Burma, Java, Thailand, Ceylon, Bombay, Poona, Mahableshwar, Bengal and Assam.

New records: Dehra Dun (U.P.) and Kangra (H.P.).

Family Agriidae

Rhinocypha unimaculata Selys

Known distribution: Bengal, Assam, Sikkim (Mungpoo).

New records: Dehra Dun, Chamoli, Pauri Garhwal, Tehri and Uttarkashi (U.P.).

Bayadera indica (Selys)

Known distribution: North Bengal and Assam.

New records: Dehra Dun, Chamoli, Pauri Garhwal, Tehri, Uttarkashi (U.P.) and Kangra (H.P.).

Anisopleura lestoides Selys

Known distribution: Bengal, Assam and Sikkim.

New records: Dehra Dun, Chamoli, Pauri Garhwal and Uttarkashi (U.P.).

Suborder Anisoptera

Family GOMPHIDAE

Anormogomphus kiritschenkoi Bartenef

Known distribution: Iraq, Persia, Persian Gulf, Mesopotamia, Baghadad, Zobeir, Mekran Coast and Sind.

New records: Dehra Dun (U.P.). This species has been recorded from India for the first time.

Family LIBELLULIDAE

Cratilla lineata (Brauer)

Known distribution: West coast of India, Nilgiris, Malabar, Bengal, Burma, Ceylon, Malaysia, Sunda Archipelago, Borneo, New Guinea and Philippines.

New records: Dehra Dun (U.P.).

Brachydiplax sobrina (Rambur)

Known distribution: Bombay, Travancore, Malabar, Coorg, Bangalore, Bengal, Assam and Ceylon.

New records: Dehra Dun (U.P.), Kangra (H.P.) and Hoshiarpur (Punjab).

Diplocodes nebulosa (Fabricius)

Known distribution: West coast of India, Madras, Fraserpet, Coorg, Mysore, Ceylon, Australia, Java and Lower Burma.

New records: Dehra Dun (U.P.) and Kangra (H.P.).

ACKNOWLEDGEMENT

We are highly grateful to Dr. A. P. Kapur, Director, Zoological Survey of India, for providing us facilities to do this work.

ZOOLOGICAL SURVEY OF INDIA,
DEHRA DUN,
November 24, 1970.

ASKET SINGH
MAHABIR PRASAD

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22. HEXAGONAL CELL OF LAC INSECT

The normal shape of the cells of lac insects is elongate for male and globular for female. All lac male insects perish after mating and then entire colonies consist of females. A single female lac cell is normally smoothly rounded. However, occurrence of hexagonal abnormal cells, referred to as 'crown shaped cell' (Mahdihassan 1968), has also been reported occasionally.

Hexagonal cells are not characteristic of any particular species of lac insect or the host-plant (Chauhan 1967), but they have been so far noticed only in 3 species of lac insects:

(i) Mahdihassan (1948) has reported that in *Kerria communis* some male insects on dispersal and due to sex reversal become hexagonal females.

(ii) Mahdihassan (1968) has reported that such crown shaped cells are numerous in *Kerria sindica*.

(iii) Chauhan (1967) has found such cells in both *rangeeni* and *kusumi* forms of common Indian lac insect, *Kerria lacca*.

The number of host-plants, on which such cells have been reported earlier, is also small. Whereas the above records of Mahdihassan are on *Zizyphus jujuba, Ficus mysorensis* and *Acacia arabica,* Chauhan (1967) has found them on 9 plant species, excluding *Ficus.*

Recently in our colonies of lac insects, one hexagonal cell, belonging to *Kerria* sp., has been growing on a fig plant, *Ficus carica* Linn. (Fam. Moraceae), at the Science College campus of the Patna

University. It is developing in complete isolation from any other lac cell, and is following the summer generation life cycle (i.e., Oct./Nov. 1969—May/June 1970).

DEPARTMENT OF ZOOLOGY,
PATNA UNIVERSITY,
PATNA,
May 1, 1970.

GOURI GANGULY
R. K. VARSHNEY

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23. OCCURRENCE OF *MELANAGROMYZA OBTUSA* (MALLOCH) ON BHINDI

The pod fly, *Melanagromyza obtusa* (Malloch) has been recorded as a serious pest of *Cajanus indicus,* "cajan", (Hindi-Arhar) in Madhya Pradesh, Bihar, Punjab, Uttar Pradesh, Himachal Pradesh and Orissa by Pradhan (1969)[1]. So far no host plants other than *Cajanus indicus* were recorded. However, the authors have noted the incidence of *Melanagromyza obtusa* on *Hibiscus esculentus* (Hindi-Bhindi) at Raipur in Madhya Pradesh.

During the couse of observation in the month of April, 1970, the attack was noted on leaf pedicels of Bhindi plants. The infested leaves were found dried and dropping down. The maggots bored the leaf pedicels (stalks) which consequently resulted in drying of leaves. While recording the incidence of pest in the field, 30 per cent plants were found attacked by this pest. There were 1 to 3 larvae per pedicel.

In the course of rearing work, it was found that 17.4 per cent of the pupae were parasitised by *Eurytoma* sp.

This is the first report of the incidence of *Melanagromyza obtusa* (Molloch) on *Hibiscus esculentus* in Madhya Pradesh.

We are thankful to R. G. Fennah, Director of Commonwealth Institute of Entomology of London for identification of insects.

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COLLEGE OF AGRICULTURE,
CENTRAL RICE RESEARCH STATION,
RAIPUR (M.P.),
January 15, 1971.

R. K. PATEL
M. L. VERMA

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[1] PRADHAN, S. (1969): Insect pests of Crops. National Book Trust, India, Delhi. pp. 71.

24. FIRST RECORD OF THE ENCYRTID GENUS *CALLIPTEROMA* MOTSCHULSKY 1863 (HYMENOPTERA: CHALCIDOIDEA) FROM INDIA

(*With five text-figures*)

The genus *Callipteroma* Motschulsky, 1863, has four species, and three of these, namely, *C. quinqueguttatum, C. sexgutttatum* and *C. testacea* were described by Motschulsky (1863) from material collected in Ceylon. The fourth species, *C. nigrum,* was described by Mercet (1924) from Spain.

The species collected by me has five hyaline spots on the fore wings and is identified as *C. quinqueguttatum* (Figs. 1-5). This species is known to occur in Ceylon (Motschulsky 1863) and Japan (Ishii 1928; Tachikawa 1962, 1963). This is the first record of the genus *Callipteroma* from India.

Material: 1 ♀, Uttar Pradesh, Aligarh, 6. iv. 1968, Coll. M. Hayat, on grass by sweeping. The specimen is deposited in the Zoology Museum, Aligarh Muslim University, Aligarh.

ACKNOWLEDGEMENT

I thank Prof. S. Mashhood Alam, Head of the Department of Zoology for useful suggestions and for providing research facilities in the Department.

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ALIGARH, U.P.,
March 22, 1971.

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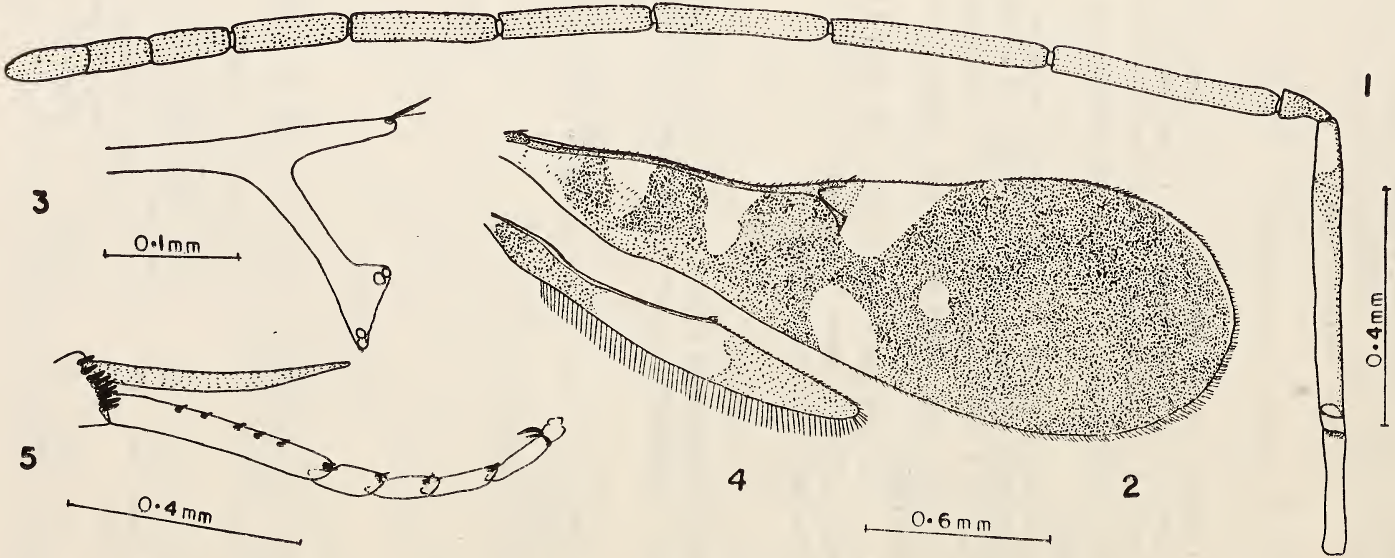
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Figs. 1-5. *Callipteroma quinqueguttatum* Mots. (1) Antenna, (2) Fore wing, (3) Part of venation of fore wing, (4) Hind wing, (5) Part of middle leg.

25. NOTES ON BOMBAY PLANTS

(*With five photos in two plates*)

1. Observations on the genus *Asparagus* at Khandala and the adjoining Plateau (Maharashtra).

The genus *Asparagus* was known to be represented in the Western Ghats and its adjoining Deccan Plateau, from a group of three species, namely, *Asparagus racemosus* Willd., *A. jacquemontii* Baker, and *A. laevissimus* Steud. ex. Baker. These are detailed by Cooke in his FLORA OF THE PRESIDENCY OF BOMBAY. Recent publications, however, do not distinguish all the three taxa. Father Santapau, after over two decades of critical work on the plants of Khandala has reduced *A. jacquemontii* Baker to the synonymy of *A. racemosus* Willd. Vartak (1953, 1956-57 & 1971), lists a single species of *A. racemosus* Willd. in these areas.

Further, *A. racemosus* Willd. is known under the name of *shatavar*i and though is of wide economic interest for its roots, yet none of the floras give a full description of the roots. Hooker says 'roots tuberous', while Cooke describes 'rootstock tuberous' in respect of *A. racemosus* Willd. Cooke adds: 'The oblong fleshy tubers are often candied for the table'. There is no mention about the roots of the other two species either by Hooker, or by Cooke. Subsequent authors including Father Santapau, too do not make any mention of roots.

In our routine botanical exploration in Wadgaon taluka adjoining the Khandala area, the junior author had a whole plant of asparagus, the roots included, carefully dug and lifted out of ground. This revealed a cluster of long roots all cylindrical and of uniform thickness (see plate 1, photo I, fig. a). We have counted up to 100 roots in a plant which measured 20 to 100 cm in length, 0.9-1.2 cm in thickness. Their tips never taper. The roots are borne on a sympodial rhizome which gives rise generally to a single shoot each season at one end. The shoots are apparently annual or biennial. These plants are further characterised by scandent habit, small cladodes and pedicels which are articulated below the centre (in fruit). This taxon is referable to *A. laevissimus* Steud. *ex* Baker.

We have also similarly examined in the field the roots of the Khandala plant. Here too the roots are borne in a bunch but the individual roots are different, being tuberous, spindle-shaped and tapering especially at the apex into a long thread-like beak. They also have a narrowed fibre-like basal stalk (see plate 1, photo I, fig. b). The roots are up to 75 in number, comparatively short and stout, being 13-38 cm long and 0.9 to 1.6 cm (mostly 1.5 cm) thick. These plants are further characterised by slender climbing habit, large cladodes, and pedicels articulated above the centre (in fruit). This is *A. racemosus* Willd. re-established by Father Santapau in the FLORA OF KHANDALA. The plants in the adjoining Lonavala hills, as well as in Purandhar Fort hill and Mahabaleshwar belong to this taxon.

Our investigations also show that *shatavari* roots are marketed in about 5 cm long cut pieces. Further as stated by Kanitkar *et al.* (1969), commerical drug samples in Maharashtra are cylindrical with even thickness as compared to the north Indian samples which have mostly a tapering end. Apparently enough, the Maharashtra and the north Indian materials are referable to *Asparagus laevissimus* Baker and *A. racemosus* Willd. respectively, but more data is needed for confirmation of their botanical identity.

2. Abnormal flowering of *Zingiber macrostachyum* Dalz. in Khandala.

There are two species of *Zingiber* in Khandala, both of which are known to produce flowers (in cone-like spikes), directly from the ground. Recently the junior author has come across an abnormality and a plant was noticed to bear flowers at the tip of the leafy shoot. This plant is referable to *Zingiber macrostachyum* Dalz. in all other characteristics.

A specimen was collected for the Herbarium and a photograph of the same is reproduced here along with the normal plant (plate 1, photos II and III).

3. *Premna latifolia* var. *viburnoides* C. B. Clke.—a new record for Western India—(plate 2, photos IV and V).

This is a plant thus far reported only from south India (Kerala and Tamil Nadu). It is not listed in any floras dealing with the plants of Bombay. However, the plant very rarely flowers in Bombay which may be a reason why it escaped the attention of previous botanists. Further, none of the floras give a full description of the plant.

We give below the nomenclature, botanical description based on our collections, etc. of the taxon:

Premna latifolia Roxb. var. **viburnoides** C. B. Clke.

In Hook. *f.* Fl. Brit. Ind. 4:578, 1885; Gamble Fl. Pres. Madras, 767, 1921.

P. viburnoides Wall. Cat. 2646b, 1831, *nomen nudum.*

A large *shrub* 4-8 m high with corky light-yellow bark; young green branches, and leaves drying olive green. *Leaves* thin, pleasantly

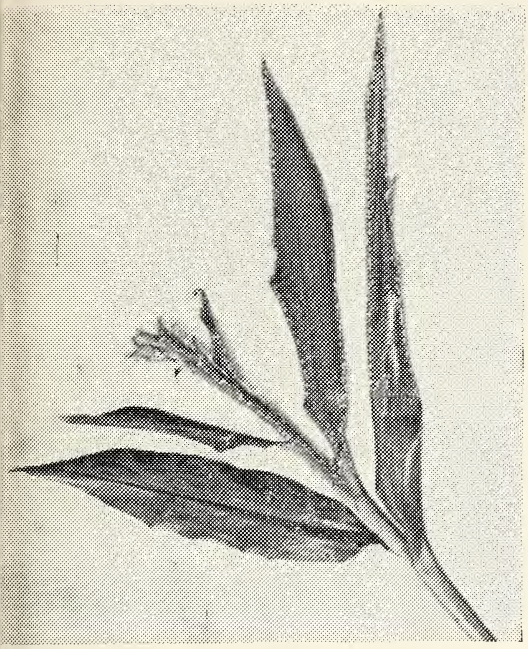


Photo II: *Zingiber macrostachyum* Dalz.—Terminal part of the flower-bearing leafy shoot.

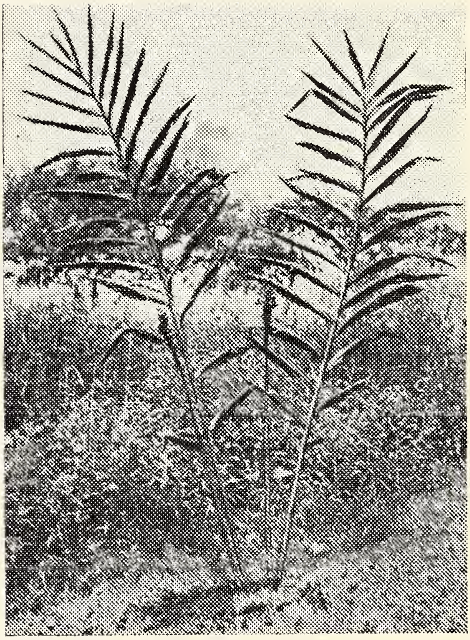


Photo III: *Zingiber macrostachyum* Dalz.—Habit (normal).

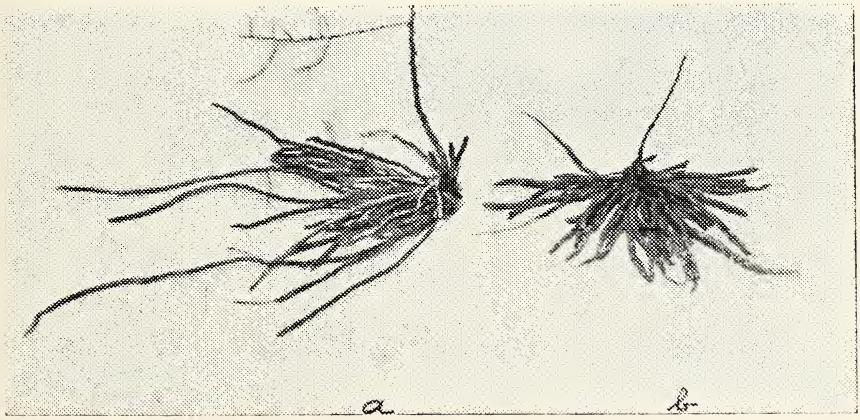
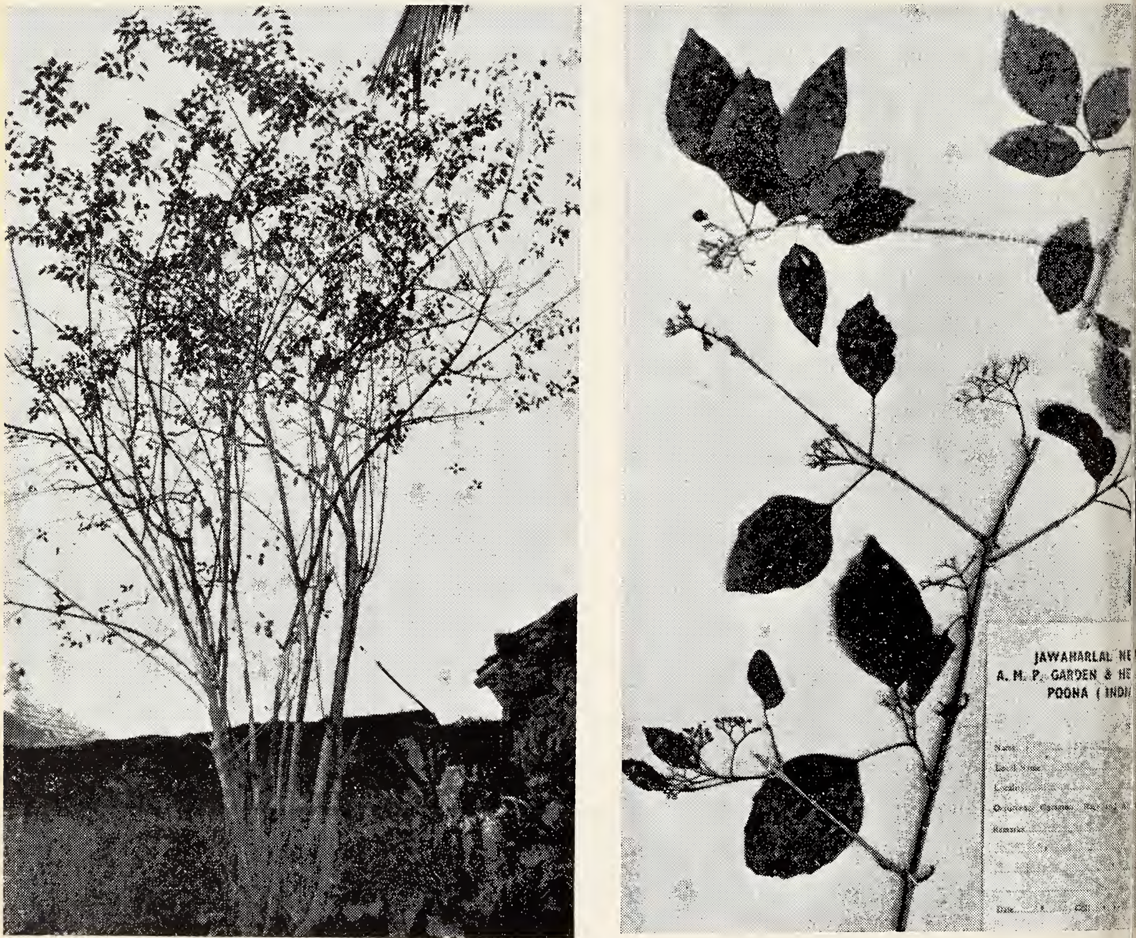


Photo I. fig. *a*: *Asparagus laevissimus* Steud. *ex* Baker—Roots with basal part of the shoot.
fig. *b*: *A. racemosus* Willd.—Roots with basal part of the shoot.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A. M. P. GARDEN & HE
POONA (INDI

Premna latifolia Roxb. var. *viburnoides* C. B. Clke.
Left. Photo IV: Habit. *Right.* Photo V: Herbarium sheet showing branches with flowers and with

scented, notably when crushed, decussate, glabrous, generally ovate to ovate-lanceolate, or ovate-oblong, serrate, or less often entire (notably on fruiting branchlets), 5-9 cm long, and 3.3-6 cm broad, acute-apiculate, rarely somewhat obtuse at the tip; base variable, generally cuneate or rounded; petiole 1.5-3.5 cm long. *Inflorescence* corymbose panicle, terminal on branchlets; peduncles and pedicels tomentose-ferruginous being covered with scales and hairs. *Flowers* hermaphrodite, often polygamous, greenish-white in dichasial cymes, bracts and bracteoles present; pedicels up to 1.6 mm long, pubescent. *Calyx* 1.8 × 1.8 mm, glabrous being covered with scales on the outside but devoid of hairs, 2-lipped, one lip 2-lobed, the other indistinctly 3-lobed, lobes ovate-obtuse, 0.75 mm long, the calyx acrescent, and about 4 mm broad in fruit. *Corolla* 5 mm long, 2-lipped, densely bearded within, glabrous outside, lobes 2 + 3. *Stamens* 4, didynamous, epipetalous. *Ovary* hypogynous, depressed-globose, 1 mm long, glabrous; style terminal 2.5 mm long, bifid. *Fruits* few, drupe, 5 mm across, light green at maturity, drying black, pericarp leathery endocarp stony, verrucose, 4-celled.

Flowering/fruiting: April to August.

Local Names: Narval (*narvala palo*—leaves), Naroli, Narvela.

Specimens examined: a. *Bombay*—R2715 (16 September, 1956) R3344 (November, 1956), R4206-4207 (July, 1957). These specimens are housed in Blatter Herbarium. b. *Goa*—February, 1971(in leaf only). c. *Poona*—October, 1971 (in leaf only). d. *South Kanara*—R5378-87 (May, 1971). These specimens are housed in the Herbarium of the JNAMPG & H, Poona.

Ecological and distribution notes: Semi-wild often grown in gardens, near homes, more as a useful species (see also below, under economic uses), in Bombay, Poona, Goa and South Kanara. Apparently more common in the coastal areas. It is often associated with *Premna obtusifolia* R. Br. (syn. *P. integrifolia* Linn. *nom. illeg.*), but may be differentiated at once by its characteristic pleasant aroma, thin leaves, larger flowers, etc. The latter *P. obtusifolia* R. Br. gives, a most offensive odour; leaves coriaceous, flowers decidedly smaller and calyx different.

Economic uses: Tender leaves ground with rice, etc., then fermented and fried into a much sought-after sweet called "dosa". Leaves are also used in medicinal oils. Roots are said to be used as *agnimanth,* one of the 10 constituents of a time-honoured Ayurvedic medicine called *dasamula.*

ACKNOWLEDGEMENT

We are grateful to Dr. Harold N. Moldenke of U.S.A. for kindly confirming the identity of the taxon.

ST. XAVIER'S COLLEGE, P. V. BOLE
BOMBAY.

JNAMP GARDEN & HERBARIUM, P. R. FERNANDEZ
KOTHRUD,
POONA,
March 3, 1972.

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26. *MITRACARPUS VERTICILLATUS* (SCHUM. & THONN.) VATKE—A NEW RECORD FOR EASTERN INDIA

Mitracarpus verticillatus (Schum. & Thonn.) Vatke (Rubiaceae), a species of S. America and S. Africa was first reported from India by Sebastine and Ramamurthy (*Bull. bot. Surv. India* **9**:291-292, 1967) from Madras and Kerala States. The present record from Orissa (Bhubaneswar and Cuttack) extends its range up to eastern India. The species is often confused with *Borreria* spp. because of their close general resemblance but can easily be distinguished by the circumcissile fruits.

The plant is usually an annual herb flowering in rainy season but often also found flowering in other seasons. Old fruiting plants with somewhat rigid stem were found giving out new flowering shoots from the main branches in the month of February.

Bhubaneswar and Cuttack, common along roadsides and in fields, fl. 24.ix.71, fr. 8.ii.72. *Saxena* 142, 626.

REGIONAL RESEARCH LABORATORY, H. O. SAXENA
BHUBANESWAR,
ORISSA,
July 25, 1972.

27. *SOLANUM TRIQUETRUM* CAV.—AN ADVENTIVE SPECIES IN RAJASTHAN

Solanum triquetrum Cav. is a native of America. This species was reported for the first time from India near Aligarh (Uttar Pradesh) by Hussain (*Bull. Bot. Soc. Beng.* 22 (2):223, 1968).

During the course of a botanical exploration of south-eastern part of Rajasthan, I collected some specimens of *S. triquetrum* Cav. from the vicinity of Devari village in Kotah district, Rajasthan. Devari is situated at a distance of about 100 km to the east of Kotah on Kotah-Shivpuri road. Here, the species is found in dry, bare fields.

The specimens have been deposited in the Harbarium of National Botanic Gardens, Lucknow (*V. Singh* 90608, LWG).

DEPARTMENT OF BOTANY, VIJENDRA SINGH
J. V. COLLEGE, BARAUT,
(MEERUT),
March 17, 1972.

28. 3-VALVED ENDOCARP OF *JUGLANS REGIA LINN.*

(*With a photo*)

The drupe of *Juglans regia* Linn. is characterised by the green fleshy exocarp and hard endocarp- the 'shell'. The 'shell' splits into a pair of similar 'boats'. Such a 2-valved (normal) endocarp is also reported in the WEALTH OF INDIA, *Raw Materials* (H-K), 5:298-305; 1959. However, during field studies in the Kashmir valley in the year 1972, I found a 3-valved endocarp which has not been recorded in our floras[1].

Popularly known as the walnut, *Juglans regia* trees yield delicately-flavoured nut with edible seed; the wood is expensive.

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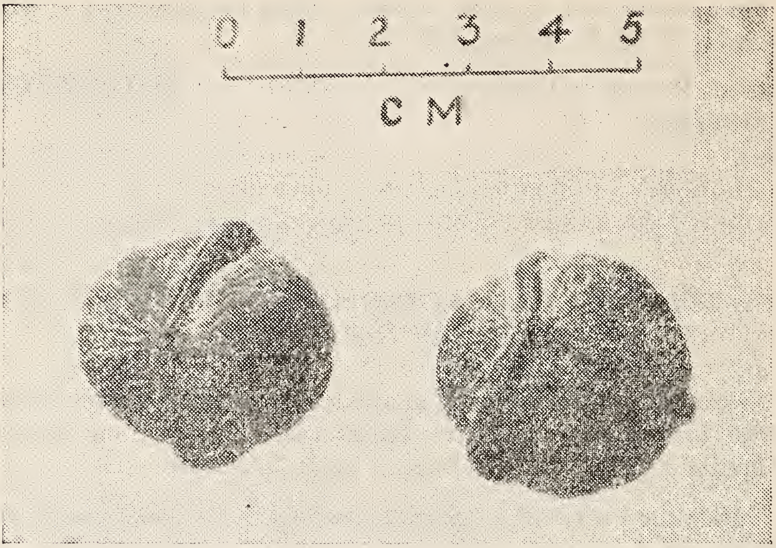
[1] Such uncommon abnormalities are not usually recorded in floras but may perhaps be recorded elsewhere.—Ed.



2-valved 3-valved
Endocarp of *Juglans regia* Linn.

General Education Centre,
Maharaja Sayajirao University
of Baroda,
Baroda 2,
July 25, 1972.

G. M. OZA

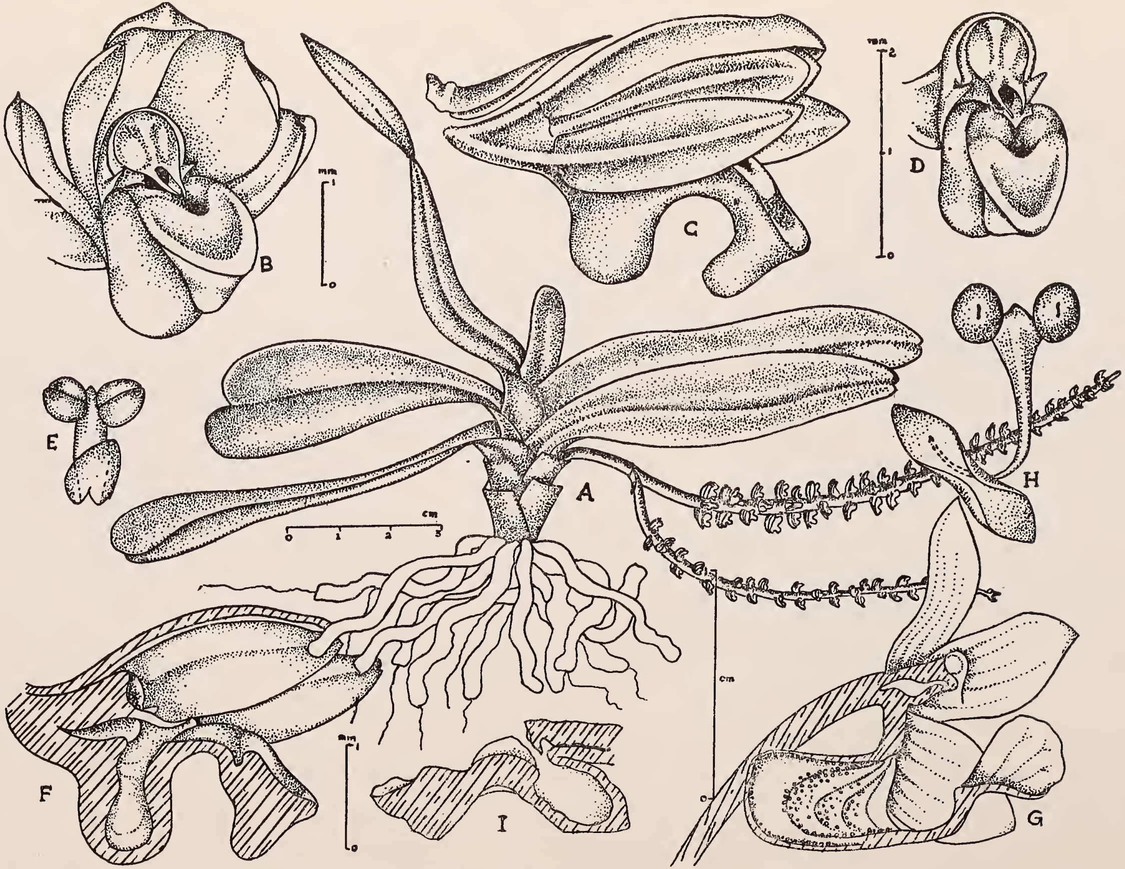
29. *SCHOENORCHIS LATIFOLIA* (ORCHIDACEAE) NEWLY TRANSFERRED FROM *RHYNCHOSTYLIS*

(*With a plate*)

A fairly common epiphytic orchid from Kadmane, Hassan district, Mysore State, was described under the name *Rhynchostylis latifolia* by Fischer in 1927. It was based on a collection made by Barber (*Barber* 6093, preserved at Kew and at Coimbatore, MH).

A closer study of the type material as well as of living plants from the type locality, shows that it cannot be included under *Rhynchostylis* Blume, an Asiastic genus of about 15 species and represented in south India by the elegant *R. retusa* Bl. This taxon has a laterally flattened, thin walled spur covered on the inside by numerous hairs (fig. G). The epichile is more or less dorsiventrally flattened and projects forwards and upwards. There are 2 slightly notched, round pollinia attached to a fairly long slender stipe having a small gland at the tip (fig. H).

Saldanha: *Schoenorchis latifolia*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1—*Schoenorchis latifolia.* A. Entire plant; B. flower, front view; C. flower, lateral view; D. column and lip; E. pollinia with stipes; F. sectioned flower. 2—*Rhynchostylis retusa.* G. sectioned flower; H. pollinia. 3— *Schoenorchis gemmata.* I. section of flower (after Seidenfaden and Smitinand).

However, *Rhynchostylis latifolia* Fischer has a fleshy rounded spur which in cross-section shows a thick wall (fig. F). The wall is slightly swollen to form a constriction half way down the glabrous interior of the spur. The epichile is uniloaded, recurved and ends in a solid fleshy conical knob pointing towards the spur. It has a median furrow starting half way from the tip and leading to the spur. There are 4 pollinia in 2 pairs (fig. E). Each pair consists of 2 slightly unequal, closely appressed pollina, sub-globose *in situ* but semilunar and slightly hollowed when separated. The stipe is relatively short and ends in a narrow gland. The rostellum has 2 tongue-like projections (fig. D) blocking the entrance to the spur and fitting into the groove of the epichile. This plant is not a *Rhynchostylis*.

It has to be shifted to the heterogenous complex that has been called *Saccolabium* Bl. by Hooker (1894, p. 54). Several studies made on this complex especially by J. J. Smith, Holttum and Seidenfaden have resulted in the revalidation of many earlier genera and in the erection of some new ones. *Schoenorchis* Bl. is one of the revalidated genera. The plants in this genus have 2 stem forms—elongated slender drooping stems with long internodes or short thick stems with crowded imbricating distichous leaves. There is a tendency towards rounded fleshy spurs with at most a small callus within the spur cavity. The epichile shows a reduction in the lateral lobes accompanied by a thickening of the midlobe. In *Schoenorchis micrantha* Bl. & *S. gemmata* (Lindley) J. J. Smith the midlobe curves backwards and the tip is swollen into a knoblike structure (fig. I). Another characteristic of the genus is the prolongation of the tip of the anther cap and of the rostellum into a drawn out tongue like structure which is parallel to the column.

Most of these characteristics are found in the Kadmane plant. The indistinguishable side lobes and the perpendicular rostellar projections are minor variations which can fit in well into the generic concept of *Schoenorchis* Blume. The following combination is therefore proposed:

Schoenorchis latifolia (Fischer) Saldanha com. nov

Rhynchostylis latifolia Fischer in Kew Bull. 1927:358. 1927.

Our thanks are due to Prof. R. E. Holttum and Dr. D. H. Nicolson for their valuable suggestions and to the Smithsonian Research Foundation for support.

ST. JOSEPH'S COLLEGE,
BANGALORE,
March 24, 1972.

CECIL J. SALDANHA

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ZAFAR FUTEHALLY
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JOURNAL
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1973 DECEMBER Vol. 70 No. 3

The Changeable Hawk-Eagle, *Spizaetus cirrhatus* (Gmelin)[1]

BY

S. M. OSMAN
11-*D*/10, *Circular Road, Dehra Dun, U.P.*

The Changeable Hawk-eagle is particularly common along the foothills of the Himalayas, and is seen all over the terai. In the Dun valley, where I have spent the greater part of my life, it is very common. I have been fortunate in having not only watched it in the wild state, but also to have trained quite a few of these birds and enjoyed hundreds of hours hunting with them.

My father had twice failed to subdue the cast-iron will of this bird. On the first occasion, one of these eagles had broken loose and devoured a fine sparrow-hawk in the same mews, after which the attempt to train it had been abandoned and it was released. A second attempt, though training pressure was maintained for months, was equally unsuccessful and this bird too was finally released.

My own first brush was also frustrating. I was on the cart track to Tapoban, only about a mile and a half from Dehra Dun, when I saw an eagle fly out from the sal forest and perch on a cottonwood tree growing on the near bank of the dry bed of the Nalapani river. Its stealthy movement and the fact that it had perched on the topmost branch of the cottonwood, commanding a wide view, were clear indications that it was on the hunt. I had with me a brand-new *dogaza* which I had knitted the day before from Krishen Mark twine. I quickly set up my trap and took cover. Through binoculars I identified the eagle as a *cirrhatus*,

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[1] Accepted April 19, 1973.

probably a three-year-old female. She was keenly interested in the baited trap and soon took off and flew towards it. To my delight she crashed into the net, but almost immediately after rose again and headed back towards the sal forest from which she had emerged. To my intense chagrin I found the eagle had made an enormous hole in my net.

The bird deserves the appellation Changeable for I have come across it in what seem to be three distinct varieties. The eagles seen along the foothills of the Himalayas are predominantly of the white variety. They are extremely short-crested with their upperparts dark grey-brown in colour. The tail is barred with dark brown bands, that appear in a faded form on the underside. The subterminal band is the broadest and the most prominent. The underparts are mainly white, with brown or dark chocolate streaks. The flanks and thighs are barred a brick-brown shade, and the prominence of these bar-shaped markings is a good guide to the age of the eagle. The tarsus, which is feathered, is livid white with faint reddish-brown markings that show up more and more prominently as the eagle advances in age.

Then there is a variety that may be seen in the thick rain forest. I call them dark-phase birds. I have only once had the opportunity to handle this variety and the bird was of a very dark chocolate-brown colour. Its breast was covered with broad, dark brown streaks or elongated spots, in such profusion that the general impression was of an almost totally dark brown breast. The upperparts also were of a black-chocolate colour. There were a few erectile feathers on top of the head, looking rather like a dilated hood when the eagle raised its hackles.

Somewhere between the dark and the light birds there is yet a third variety. It is to be found along the lower Siwaliks in the Saharanpur Division jungles. In this variety the crest is well defined and the upperparts are similar to those of a Goshawk. Rarely if at all is a large female more than twenty-five inches in length. The average length of an adult female of the first two varieties is about twenty-three inches.

I have found nests in many different places, and have come to the conclusion that Changeable Hawk-Eagles confine their nest-building activities to the largest trees, right in the middle of the forest. I have found no evidence that nests are ever built on ledges of rocks in the hills or on inaccessible cliffs. On the plains and in the forests it is generally the biggest banyan tree that harbours a nest. Rarely a giant mango may also be chosen, and on one occasion I found a nest on top of a colossal sal. Once I heard of a pair of the third variety nesting in a pipal tree not far from a village, though I was unable to see the nest myself.

I have observed these birds flying noiselessly about the forest. They are very careful not to expose themselves, and flit from tree to tree like shadowy ghosts. They sit as still as stuffed specimens waiting for game to come out of cover, and noiselessly launch their attack with lightning speed. Nothing within reasonable size and weight is safe from their attack.

I was doing reclamation work near the Susuwa river, and was watching one of these birds through binoculars. The tree where the eagle sat was surrounded by patches of bramble bushes with open spaces in between, a most likely spot for junglefowl to come out to feed. Then a partridge began calling some distance away. The eagle immediately changed its position to face the sound, and took off towards it. It flew low, a few feet above the ground, making a cunning and stealthy approach, but when near its target the eagle shot up high above the trees before it swooped. A scream from the partridge indicated that it had been taken, and I ran over just in time to see the eagle fly into the forest with the dead partridge in its claws.

The eagle had estimated the approximate whereabouts of the partridge by sound alone, had approached it low down, and then soared to pin-point its victim visually, and to be in a position to dive on its prey instead of having to chase after it. The hawk-eagle hunts with a deliberate calculating intelligence not found in many other hawks. It is small wonder that it takes all the skill and patience of a falconer to train these birds, almost human in their reasoning power.

The Changeable Hawk-Eagle is the most vociferous of all the hawk-eagles, calling throughout the year, even when soaring high above the forest canopy. One male bird that I owned used to call all day whether on the perch or on the fist. The sound was shrill and unmusical at close quarters but it had a plaintive sort of resonance, not altogether unpleasing to the ear, when heard floating down from the heights where the bird was soaring. When not hunting, the call is a sharp, plaintive *kwe*, *kwe*, *kwee* repeated at regular intervals, but the hunting or contact call is a soft *kee*, *kee* frequently repeated. The *kwe*, *kwe*, *kwee* call is audible for a mile or more.

Nesting in the Doon valley begins early in the month of March. At that time the pairs are heard calling almost non-stop to each other, and all the while they are busily engaged in the business of nest-making. During this period they generally hunt in pairs, and hare, junglefowl and other small game and rodents are taken. If short of food they will attack and tackle peafowl and fawns also. They do not scorn rats and on several occasions I have watched them feeding on locusts. They are even known to attack cats when hungry, and a jungle cat is quite a powerful little beast that does not easily permit liberties to be taken with it. I really do not know whether these eagles, like some of the others, indulge in piracy. I suppose they would and could rob other, less powerful raptors of their kills if need arose.

In 1945 a very big and almost white eagle had taken up residence close to Jhora Block in the Motichur Range, in a pretty patch of jungle teeming with game of all kinds. Whenever I visited the area I saw the eagle.

I think it was towards the end of March, when I one day disturbed her as she sat feathering a Sarus crane. Whether the job had been accomplished alone, or she had been helped by her mate in pulling down the big crane, I do not know, but she was the biggest eagle in this group of birds that I have ever seen and definitely looked capable of pulling down a Sarus all by herself. In the months that followed, I tried very hard to capture this bird. She never got to the stage of flying down to the net though she was not afraid of man and would allow me to stand right under the tree on which she was sitting.

No matter how early I arrived I would always find her with a full crop, having finished her breakfast, so it is not surprising that she was not in the least interested in the live pigeon I repeatedly offered behind my *dogaza*.

Though I have examined quite a number of nests, I have never found a bigger clutch than two. Soon after the eggs hatch, and for more than a fortnight afterwards, the parents are feverishly active, coming and going to the nest with food for the eaglets. I have watched the mother bring gamebirds sometimes, but usually rats and squirrels. As they grow the young birds become more and more noisy at meal-time, and when about two and a half months old the eaglets display a great deal of ferocity, snatching food from the parents' claws. At the sight of their parents, the eaglets generally demonstrate by much wing-flapping and screaming. Though the idea does not appeal to me personally, it would be an interesting experiment to see how a three-quarter-grown bird would respond to training.

The first *cirrhatus* eagle that I trained was of the dark phase, and I shall never forget the trouble she caused me. Not far from Dehra Dun, on the way to Hardwar, there used to be a tea-garden where the Indian Institute of Petroleum now stands, and we were shooting junglefowl in the tea-garden. The eagle came down to the net almost immediately, so capturing her was no problem. She was not pretty. Her feathers from crop to belly were all dark chocolate, with the upperparts and head almost black. She did not have a crest but presented a most savage and ferocious appearance, with hackles raised like a dark hood around her upper neck and head. She was extremely shy in the beginning, a characteristic she never totally lost.

In fact she was so shy that for almost a month she would not preen her feathers if anyone was present. I was up against a wall of resistance every day for three months, but gradually she started to jump to the fist from very short distances. But she would only fly up. She would readily fly to the fist if called from the block perch, or from the lawn, but would not fly down from the branch of a tree or the top of a building.

This was naturally very annoying, and my skill as a falconer was at stake. My uncle took to deriding me by saying ‘ It’s time you admitted defeat. No point in wasting any more effort on that bird.’

With a tremendous amount of handling and attention I was able to dispel some of the bird’s fear. Little by little, I got her to fly down from heights of more than ten feet, and after a lot more gruelling work I was able to get her down from the top of any tree. Even so I was never sure she would come when called. She never showed any real interest in game, and the only time she was really flown was at a squirrel. This she somehow managed to bag, but it is not much to make a song about. So I abandoned the attempt to make this bird fieldworthy, took her back to Motichur and liberated her. Almost a year later, when I was again in that part of the eastern Doon valley, I found her sitting on a khair tree. How, the reader may ask, could I be sure this was the same bird I had released ?

In this case identification was not at all difficult. My eagle had a slightly deformed beak, and I could see through my binoculars that the lower mandible of this eagle was distorted in exactly the same way. The colour scheme also matched to the last feather. The falconer who has spent many months toiling away, sapping at the foundations of an eagle’s will to resist training, will at a glance be able to discriminate between a wild eagle and an old aquaintance.

Looking back to the time when I suffered so much just to get the eagle flying to the fist, I now feel that the labour and the wounds were not totally unavailing. I am reminded of the old saying that ‘ No man is entirely worthless, for he can always be pointed out as a horrible example ’. At least one common assertion of falconers, that a hawk of the dark phase is very difficult to train, had been proved correct. And my eagle had had the characteristic which Oriental falconers look upon as a real disqualification, a drooping tail. According to the masters, the bird will be difficult to break if the tail droops and does not extend in the same plane as the body of a hawk or falcon. They say that in any bird of prey the tail should be in line with the body slant when it is perched.

I never had much trouble with the light-phased *cirrhatus* hawk-eagles, though I have kept and trained many of them. I have been observing them for well over twenty years and have faithfully recorded changes in their colour scheme and markings after each moult. During the first year, when birds are in juvenile plumage, all markings are faint and irregular, and the general impression is of faded hues, so that the eagle has an almost ivory-white appearance on the breast. The wing-coverts are not as contrastingly shaded as in grown-up birds. A few faint and thread-like streaks on the breast help to break the monotone of the front coverage.

After every moult, each year the streaks become more numerous and darker in shade, till they extend right down to the belly of an eagle that is more than five years old. After the third moult, the markings on the front and especially around the crop and breast start becoming broader. This broadening of the streaks is particularly evident at the lower ends of the markings, until the spots are like tear drops in a bird more than eight years old. The faint bar-shaped markings on the thighs of immature birds gradually become firmly etched, and in a five-year-old eagle extend down along the tarsus right to the toe-joints. Here the feathers end. The feathers of the *cirrhatus* hawk-eagles, unlike those of the Mountain Hawk-Eagle, do not grow in between the toe-joints. Generally speaking, the old birds I have seen are more prettily marked than juvenile birds of the same group.

In the Himalayas Changeable Hawk-Eagles are not found above nine thousand feet, and in all my wanderings I have not come across any nest above that height. I have never seen them chasing birds of prey with the intention of robbing them of their kill, but it would not be wise to fly a sparrow-hawk or a goshawk in their vicinity.

Most birds of prey defend their hunting ground, but this is not so in the case of these eagles. I once came across two pairs of these eagles nesting quite close to each other. On another occasion, I found a Serpent Eagle's nest hardly a hundred yards away from the nest of one of these hawk-eagles. Obviously they are sociable birds, not given to quarrelling amongst themselves.

In one of his books about maneaters Col. Corbett mentions having seen a fight between a hawk-eagle and a wild cat, somewhere in the jungles of the terai. A fight to the bitter end. The cat, we are told, was after a long struggle killed on the spot, while the eagle dragged itself away to die some time later. Some years ago I sent a Changeable Hawk-Eagle to a German falconer friend, which made hawking history in that part of the world by eliminating cats from the countryside.

These eagles were really very plentiful in the Doon valley, but then so used to be big and small game of all kinds. Years ago I was shooting junglefowl at a place called Chiderwala. There I saw for the first time a wild *cirrhatus* chase a peacock with great determination into a thick patch of pampas grass. Immediately there followed a terrific commotion, and other peafowl in the area were screaming their heads off as I followed up. I almost stepped on to the eagle which was grasping the dead peafowl. The eagle, much disappointed, watched from a tree as I collected the peacock. Much before sunrise next day I returned to the patch of pampas grass and was overjoyed to see the eagle rise from the place which had witnessed its struggles with the peacock the day before. It flew up into a large tree a short distance away, and in a very few minutes I was pulling her out of the net, It did not take me long to get her fully trained, and within a month I could call her from the top of any tree into which I had thrown her. Some days previous to the capture of this eagle, however, I had rashly promised to give a friend my next eagle, so I had to send her away.

On a shooting expedition in the middle of March 1944 I stayed for more than a week in the zamindar's cottage at Gobindwala and noticed that every afternoon, about 2 o'clock, a Changeable Hawk-Eagle would fly out of the thick sal forest and perch on a dead haldu (*Adina cordifolia*) tree about a hundred yards from the veranda. It would stay there for about a quarter of an hour and then soar in huge spirals until it was a mere speck against the blue of the sky. We were out after Spotted Deer and I was without my *dogaza*, but the temptation to capture our regular visitor was too strong to be resisted and I sent a messenger to Dehra Dun to fetch the net and a live pigeon. I lay down that night confident of success, but ' Man proposes, God disposes '. In the night a jungle cat smashed the wicker basket containing the pigeon, and as we had to leave the next day I did not have a second chance.

Fate is not always unkind, however, as the following story will show. Between Dehra Dun and Mussoorie there is a stretch of eroded country, about seven miles broad, where the valley bottoms are so thickly overgrown with lantana, brambles and ber (*Zizyphus jujuba*) bushes that they are almost impenetrable for man. The prickly thickets however provide excellent cover for hares, junglefowl and grey and black partridge, and one winter day when I was out with spaniel and shot-gun I disturbed an eagle in one of these overgrown depressions. As it flew out it passed quite close and I was able to see that it was a *cirrhatus* and that three of its secondary feathers were broken. The day was far spent and it would soon be dark, so I hurried home resolved to return early next day to attempt a capture.

Next morning at 4 I set out. It was early, it was dark, and I remember it was bitterly cold. In fact walking in the open, immediately after getting out of a warm bed, felt like wading through cold water. To escape the dew-drenched grass that soaked me up to the knees with icy water, I decided to take a short-cut across an open field, but this proved to be my undoing, for the field had only recently been ploughed and the clayey soil clung to my boots, so that I felt that I was moving tons of earth with each step that I took. I felt really cold and miserable.

As soon as there was enough light I went down into the hollow, but the eagle was nowhere to be seen. I did not waste much time down there among the dripping cold bushes, but climbed up to the rim and scanned the horizon all round with binoculars. But the eagle had vanished so I gave up the search, and as I was numb with cold, decided to trot back home.

A sprint of less than two hundred yards was enough to part the sole of my sodden boot from its upper portion, and the going then became torture. I am not used to walking barefoot, and soon my toes were raw and dripping with blood in spite of the fact that I had wrapped my scarf round my foot instead of the boot that was lost.

By the time I got home I was pretty exhausted and in considerable pain. I had a hasty breakfast and hurried off to see the doctor about a shot of A.T.S. But I had hardly gone two hundred yards when I noticed crows mobbing an eagle in a pipal tree. It was an eagle similar to the one I had been out to capture, and was in a place where netting was possible, with open country and hedges all round. Forgotten were my appointment with the doctor and the pain in my toes as I raced back home to grab net and bait.

I soon returned to plant the *dogaza* in a likely spot, with the live pigeon as bait, and had hardly moved into cover when the eagle flew into the trap. As I extricated it from the meshes of the net, I noticed that it had three secondary feathers on the left wing badly broken. It was the same *cirrhatus* hawk-eagle I had seen the day before, and all the early morning's pain, suffering, and disappointment were richly compensated.

From a falconer's standpoint, this eagle is second to none if trained properly and handled with care. I have hunted with Bonelli's eagle and with these eagles too, and when fully trained there is not much difference between them. In the wild state, perhaps *cirrhatus* may kill more game, but for falconry they are both equally good. There is however one big difference. Bonelli's eagle is much better able to tackle game in the open country, has a stronger and swifter flight, and will pertinaciously follow the quarry for long distances, until it is captured. On the other hand the *cirrhatus* hawk-eagle is perfectly adapted for hunting in thickly wooded country. There it is in its element and performs best. Its talons are very powerful. Hares are generally caught by the small of the neck and if the eagle attempts to lift the quarry thus gripped the neck is generally broken.

In all the *cirrhatus* eagles I have come across, I have found symptoms of tapeworm infestation. I have tried all sorts of remedies for the removal of this pest, but it seems impossible to eradicate the parasite. Dicestal, as recommended by the makers, may be tried, and has a favourable short-term effect, but usually the head of the worm remains embedded in the intestines, and grows again. Therefore repeated doses are necessary, and the interval between doses may be easily determined by a pathologist by examination of the mutes.

In this species, male birds (tiercels) are easier to handle. They are smaller than the females and much more manœuvreable, with the ability to dart in and out of thick bushes with amazing dexterity. They are quite capable of running down hares, peafowl, and other game generally taken by the female birds. They are very good in catching junglefowl, but the falconer should know how and when to tackle the wary cock birds. The best time to strike is when the birds are feeding in the open. Then a long slip may be tried. As soon as the junglefowl see the eagle they rush for cover and the eagle perches in a tree from which he can keep watch. You then have to flush the fowl again, in such a way that the birds are so to speak driven towards the eagle. With a well-trained dog this is not difficult. As the birds fly from cover the eagle will shoot out of the tree to bind with its quarry in mid-air. I have tried this method many times, and have very rarely failed to register a kill.

Some Snakes from Nepal[1]

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Data on 103 specimens representing 29 species of snakes from Nepal are given. These snakes were collected in central and eastern Nepal at altitudes ranging from 100 m to 2470 m. Twelve species of snakes reported from Nepal for the first time are : *Dendrelaphis tristis*, *Elaphe helena*, *Boiga cyanea*, *Boiga forsteni*, *Enhydris enhydris*, *Enhydris sieboldi*, *Elachistcdon westermanni*, *Bungarus caeruleus*, *Bungarus fasciatus*, *Naja naja*, *Ophiophagus hannah*, and *Typhlops braminus*. Early collections from Nepal lack accurate data, thus *Elaphe hodgsoni*, *Amphiesma himalayana*, *Sibynophis collaris and Calliophis macclellandi* are reported from Nepal for the first time with accurate locality and altitude data. *Boiga trigonata*, *Lycodon aulicus*, *Xenochrophis piscator*, *Amphiesma stolata*, *Ptyas mucosus* and *Trimeresurus albolabris* were not previously known from the Nepal lowlands. Likewise *Amphiesma himalayana*, *A. platyceps*, *A. stolata*, *Xenochrophis piscator* and *Trimeresurus monticola* have been found for the first time in east Nepal.

INTRODUCTION

Despite scattered collections made during the past 150 years, the reptile fauna of Nepal remains poorly known. An excellent summary of herpetological work done in Nepal up to 1960 was presented by Swan & Leviton (1962).

Since 1960 there has been little herpetological work done here. In the mid-1960s an enthusiastic Swiss national collected snakes as a hobby while working at the Tibetan Refugee Camp in Pokhara. Unfortunately he was bitten by a snake (probably the Coral *Calliophis macclellandi*) and died within the day. His fine collection, we heard, was then destroyed.

Snakes reported in this paper are from central and eastern Nepal at altitudes ranging from 100 m (305 ft.) to 2470 m (8100 ft.). Specimens are preserved in alcohol and are deposited in the various museums mentioned or in the Fleming Collection in Kathmandu. Identifications

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were made with the aid of comparative material where possible and with keys and descriptions in Smith (1943). Scientific terminology follows that of Swan & Leviton (1962).

A total of 29 species were represented in the 103 specimens examined. Of these, 12 species were new for Nepal, so the known snake fauna of Nepal now comprises 45 species. We have located nine species of poisonous snakes in Nepal; three of them are from the Kathmandu Valley.

ACCOUNT OF SPECIES

BOIDAE

Python molurus (Linnaeus)

Specimens examined (none).

Remarks. The Python is a well-known snake of south Nepal. It is found in forests near streams and large marshes. We have received reliable reports of this snake from west, central and east Nepal. Joseph Rheinhart, anthropologist, spoke of seeing several during his research activity in the Surkhet region of west Nepal. On 20 November 1969 we talked with an elephant ' pundit ' who had that morning run across two medium-sized (*c.* 10 feet) individuals in the forests of Chitwan. One snake was under some dead leaves; another partly concealed by grass. In February 1966 we saw ' tracks ' of a large python in the sand of a Chitwan stream. The following reports are from east Nepal:

1. A small python, *c.* 8 feet long, was killed on the Tarhara Agricultural Station grounds, Morang Dist., in 1968.

2. A very large (*c.* 15 feet) individual was seen on the banks of the Bagjhora Jheel, Morang Dist., in 1968. When discovered by our informer, it had captured and partly swallowed a Chital (*Axis axis*) hind. Rushing back to the village a kilometre away, he recruited several men to help kill or capture the snake. Upon returning to the jheel, the men made so much commotion that the python regurgitated its meal and slipped into the water. Small pythons also live in this jheel.

COLUBRIDAE

Dendrelaphis tristis (Daudin)

Specimens examined (6). RUPANDEHI DIST.: Butwal, 300 m (4), 1969: 1020 mm, 830 mm, 790 mm, and 655 mm; CHITWAN DIST.: 50 km S. Narayanghat, 300 m (1), 15 Nov. 1969: 590 mm; MACKWANPUR DIST.: Hetaura 300 m (1), Oct. 1969: head and neck only.

Remarks. The Indian Bronzeback appears to be a fairly common snake of the Nepal lowlands. The specimens were found around human dwellings located in forest; they are the first records of this species from Nepal (*see* Swan & Leviton 1962 : 140).

Boiga cyanea (Boulenger)

Specimens examined (1). MACKWANPUR DIST.: Anandaban, 15 km S. Kathmandu, 1525 m (1), 15 Feb. 1970 : 880 mm.

Coloration and Scalation. Uniform ferruginous above; light cream below darkening to pale orange-cream posteriorly. Temporal scales are 2 + 2, not 2 + 3 as listed by Smith (1943 : 355).

Remarks. This snake was caught in semi-open Pine (*Pinus roxburghii*) forest; it is the first record for Nepal (*see* Swan & Leviton 1962 : 140).

Boiga forsteni (Günther)

Specimens examined (1). RUPANDEHI DIST.: Butwal, 210 m (1), 1969 : length *c.* 1690 mm. A heavy specimen.

Coloration. Fairly typically marked with brown above interrupted with black crossbars. The lower head and neck is creamy yellow with the rest of the ventral surface light brown covered with irregular, small dark markings.

Remarks. This is the first record of the Forsten's Cat Snake from Nepal.

Boiga trigonata (Schneider)

Specimens examined (5). RUPANDEHI DIST.: Butwal, 210 m (4), 1969 : length 880 mm, 805 mm, 785 mm, and 435 mm; MACKWANPUR DIST.: Hetaura, 300 m (1), Oct. 1969 : head and neck only.

Scalation. The third to fifth supralabials touch the eye as opposed to fourth to sixth as mentioned by Smith (1943 : 345).

Remarks. This Cat Snake is apparently fairly common in the central Nepal lowlands. They were caught near houses. These are the first specimens from the Terai and Duns of Nepal. Previously they have been seen in the hills around Kathmandu and Gurkha.

Elaphe helena (Daudin)

Specimens examined (2). MACKWANPUR DIST.: Hetaura, 300 m (1), 1968; PALPA DIST.: Tansen, 1525 m (1), May 1969 : length *c.* 760 mm.

Remarks. The Trinket Snake does not appear to be common in Nepal. It is found, though, from the Duns up to at least 5000 feet in the Pahar (Middle Hills). This is the first record of this species from Nepal (*see* Swan & Leviton 1962 : 140).

Elaphe hodgsoni (Günther)

Specimens examined (5). KATHMANDU VALLEY, 1370 m (2), 1968 : 365 mm and 285 mm ; MACKWANPUR DIST. : Anandaban, 15 km S. Kathmandu, 1525 m (2), 10 Jan. 1969 : 370 mm, 27 May 1970 : 1310 mm. RASUWA DIST. : Thangbajet, 1525 m (1), 20 April 1968 : 335 mm.

Coloration and Scalation. Typical grey with two faint brown dorsolateral stripes over the grey scales becoming most distinct towards the posterior half of the body. No presubocular in any of the five specimens examined.

Remarks. All our specimens of Hodgson's Racer come from about the 5000 feet altitude level ; all are from the Central Pahar (Middle Hills). Earlier collections of this snake were without accurate locality and altitude data.

Two specimens are in the Anand Kuti Science College collections, Kathmandu.

Enhydris enhydris (Schneider)

Specimens examined (1). DHANUSA DIST. : Janakpur, 100 m (1), 27 July 1969 : length *c.* 665 mm.

Remarks. This snake is reported to be common in freshwater ponds and small streams of the Janakpur area. The local name is '*Mach giddi*'. This is the first specimen of this species from Nepal (*see* Swan & Leviton 1962 : 140).

Enhydris sieboldi (Schlegel)

Specimens examined (1). CHITWAN DIST.: 50 km S. Narayanghat, 300 m (1), Oct. 1969 : length 360 mm.

Coloration. Dark brown above with mostly incomplete cream-coloured rings on the dorsal aspect. Below blackish with white spots.

Remarks. This snake was found along the edge of the Rapti River and was not thought to be common in that area. This is the first record of this freshwater snake from Nepal (*see* Swan & Leviton 1962 : 140).

Lycodon aulicus (Linnaeus)

Specimens examined (10). KATHMANDU VALLEY, 1370 m (7) ; SINDHU DIST. : Sinduliphichowk, 1525 m (1) ; RUPANDEHI DIST. : Butwal, 270 m (2).

Remarks. The Common Wolf Snake is one of the most conspicuous snakes in Nepal for they are often caught in houses. This non-poisonous species is often mistaken for the Common Krait (*Bungarus caeruleus*) for both are cross-banded. The wolf snakes we have seen, though, have yellow bands whereas the Kraits have nearly white bands. Of eight 'Kraits' sent to us from Duncan Hospital, Raxaul (located 0·5 km from the Nepal border opposite Birganj), seven were Wolf Snakes; only one was a Common Krait. Our specimens are the first reported from the Nepal lowlands.

Amphiesma himalayana (Günther)

Specimens examined (1). ILAM DIST.: Jamuna, 1830 m (1), 21 April 1970: length c. 920 mm.

Coloration. The interstitial skin towards the anterior third of the body was an attractive bright orange; it was especially noticeable when the snake was excited.

Remarks. Our specimen was caught in a cultivated area of terraced rice fields, hedgerows and small paths. This species has been reported once from Nepal (but without exact locality data); this is the first record from the eastern part of the country.

Xenochrophis piscator (Schneider)

Specimens examined (4). MORANG DIST.: Biratnagar, 100 m (3), 11 Nov. 1968: length 690 mm, weight 105 gm, 14 Nov. 1968: 950 mm and weight 212 gm, Nov. 1968: length 845 mm: BARA DIST.: 5 m S. Simra, 120 m (1), Sept. 1969: length 705 mm.

Coloration. The specimen from S. Simra was considerably different from the others examined. This individual was a uniform dark brown on the dorsal aspect with a bright deep yellow on the ventral surface. This yellow extends up to scale row three. A dark, almost black line, occurs on scales lines three and four.

Remarks. The Checkered Keelback is common in south Nepal. Our specimens were caught near water. Some people in Morang District told us that this snake was non-poisonous for man, but very dangerous for cows. Previous collections of this snake are all from the Central Pahar (hills). These are the first records from the Terai of central and eastern Nepal.

Amphiesma platyceps (Blyth)

Specimens examined (5). KATHMANDU VALLEY: Godaveri, 1830 m (1), 5 May 1970: 600 mm; MACKWANPUR DIST.: Anandaban, 15 km S. Kathmandu, 1525 m (1); RASUWA DIST.: Syabrubesi, 1525 m (1), 22 Oct. 1969: length 770 mm; ILAM DIST.: Hake Tham (Jamuna), 2135 m (2), 22 April 1970: 650+(tail broken) mm, 11 May 1970: 715 mm and weight 45 gm.

Coloration. Four specimens are quite uniform and very similar: brown above, cream bordered with a creamy-orange below. The Syabrubesi specimen, however, is liberally marked with dark brown and hardly appears to be the same species as the others.

Remarks. This Keelback is apparently widely distributed in the hills of Nepal. Our specimens were caught in or near cultivations and human habitations. This species has not been reported previously from east Nepal (*see* Swan & Leviton 1962 : 114).

Amphiesma stolata (Linnaeus)

Specimens examined (26). KATHMANDU VALLEY: Kupendol (2), Anand Kuti College collection (2), Tribhuvan University collection (6), Shanta Bhawan Gate (3), Patan Gate (1) ; KABHRE DIST. : Sanku-Reli, 1220 m (1) ; RUPANDEHI DIST. : Butwal, 300 m (3); BARA DIST. : Simra Airport, 150 m (1), Pawnaipur, 100 m (1) ; DHANUSA DIST. : Janakpur 100 m (1); JHAPA DIST. : Gailadhuba, 100 m (1); ILAM DIST. : Ilam, 1300 m (1), Jamuna, 1525 m (2) ; CHITWAN DIST. : 50 km S. Narayanghat, 300 m (1).

Coloration. Several specimens had (in life) a most conspicuous and attractive yellow on the upper labials, lower jaw and extending down the first two centimetres of the neck.

Measurements. Our longest specimen measured 550 mm ; a specimen 525 mm long weighed 27 gm ; another 505 mm weighed 21 gm.

Remarks. The Striped Keelback is undoubtedly the most common, or at least the most conspicuous, snake in Nepal. It is found commonly in Kathmandu in grassy areas near cultivation. Our specimens from the Terai were caught fairly close to water ; none were in forest regions. Strangely enough, this snake has been reported previously only from the Kathmandu area (*see* Swan & Leviton 1962 : 114). The Nepali name of this snake is ' *Harhara* '.

Oligodon erythrogaster Boulenger

Specimens examined (2). KATHMANDU VALLEY : Godaveri, 1525 m (1), 2nd Aug. 1969 : length 555 mm, weight 97 gm ; MACKWANPUR DIST. : Anandaban, 15 km S. Kathmandu, 1525 m (1).

Coloration and Scalation. Markings and scale counts differ somewhat from those published by Smith (1943 : 196 and 232) for this species. The body scales are in 15 rows (vs. 17 for previously known specimens). There are 188 body scales ; 49 caudal scales. The arrangement of the head scales is that given by Smith. The base colour of the snake (taken from the live specimen) is grey or brownish-grey. There is a distinct vertebral stripe, 2 scales wide, running from the neck to the vent region where it changes to 1 scale wide on the tail. This stripe encompasses the vertebral scales and ½ of each adjoining scale row. This vertebral stripe is bordered by a dark maroon stripe covering exactly one scale row in width but occupying ½ of one scale row and ½ of the adjoining row. This stripe is darkened with a black border. A black stripe with a maroon tinge covers ½ scale row 2 and ½ scale row 3. Another distinctive black stripe, ½ scale wide covers ¼ scale row 4 and ¼ scale row 5. All except the vertebral stripe originate at the neck and remain uniformly wide to the vent and are not found on the tail. Ventrally, the snake is greyish maroon. The maroon of each ventral scale is edged with a distinctive white dot on the caudal half of the scale while the anterior part is black. Towards the lateral edge the ventral scales are concolorous with the grey of scale row 1. The tail is a lighter maroon than the body and from directly below the tail looks uniformly maroon with white dots on the edges just showing. The ventral caudal scales curve around the body so that the black lateral edges of these scales join to form a continuous stripe down either side. Dorsally, an orange-brown line, reduced to 1 scale in width, runs the entire length of the tail while the dark maroon stripes are reduced to ½ scale in width. The tail ends in a sharp point which pushed into the hand when the snake was handled.

Remarks. This snake appears to be uncommon. The Godaveri specimen was caught on a cloudy day in leaf litter within dense subtropical forest.

Pseudoxenodon macrops (Blyth)

Specimens examined (1). ILAM DIST. : Hake Tham (Jamuna), 2225 m (1), 22 April 1970 : length 810 mm.

Remarks. This snake was caught in dense forest as it moved along the forest floor through very damp moss, ferns and leaf litter. A severed hand of a tree frog was recoverd from the GI tract. This snake has been reported once before—from the same valley system (Mai Khola) as our specimen.

Ptyas mucosus (Linnaeus)

Specimens examined (8). KATHMANDU VALLEY : Anand Kuti Science College collection (2), Tribhuvan University collection (2), Chobar Gorge (1) ; RUPANDEHI DIST. : Butwal, 300 m (2) ; BARA DIST. : Pawanipur (1).

Remarks. Outside of the Striped Keelback, the Dhaman or Rat Snake is perhaps the most conspicuous snake in Nepal. In Kathmandu Valley they are often found around and sometimes in houses. The specimen from Chobar Gorge was curled up in the sunshine while resting on a cow dung patty. A friend was amazed recently at seeing a large snake swimming up through the Chobar Gorge, making good progress against the swift current of the Bagmati. This was likely a Rat Snake. The large individuals of Kathmandu are grey ; we have yet to see a black one. A large Rat Snake near our house in Kupendol was watched while it slowly swallowed a very large toad.

Sibynophis collaris (Gray)

Specimens examined (1). MACKWANPUR DIST. : Anandaban 15 km S. Kathmandu, 1525 m (1), May 1968 : length *c.* 485 mm.

Remarks. This is apparently a rare snake in Central Nepal. This species has been listed from Nepal but without previous locality or altitude data (*see* Swan & Leviton 1962 : 115).

Trachischium tenuiceps (Blyth)

Specimens examined (1). NAWAKOT DIST. : 3 km S. Palung, 2000 m (1), 20 Sept. 1969 : length 410 mm.

Remarks. This snake was found on the Tribhuvan Rajpath in an area of rocks and loose soil. In Nepal this species is known only from the Mahabharat Range.

Elachistodon westermanni Rheinhardt

Specimens examined (none). In Nov. 1964 a specimen was caught in Chitwan Dist., 50 km S. Narayanghat, 300 m, and sent to the Field Museum, Chicago, where it was identified by Dr. Robert F. Inger.

Remarks. This Indian Egg-Eater Snake was caught on a footpath at the edge of heavy forest and a hundred yards from the Rapti River. It was moving at dusk. This rare snake has not been reported before from Nepal (*see* Swan & Leviton 1962 : 141) and only a few specimens are known.

ELAPIDAE

Bungarus caeruleus (Schneider)

Specimens examined (6). RUPANDEHI DIST. : Butwal, 300 m (3) ; MACKWANPUR DIST. : 3 km S. of the Churia Pass, S. Hetaura, 400 m (1) ; MORANG DIST. : Biratnagar Town, 100 m (1) ; NEPAL : Locality uncertain (a specimen in Peace Corps Office presumably from BARA DIST. : Pawanipur).

Our largest specimen was 1219 mm (4 feet) long and weighed 540 gm ; 14 Nov. 1968.

Remarks. The Common Krait, though not previously reported from Nepal (*see* Swan & Leviton 1962 : 141), is a fairly frequent snake of the lowlands. The Mackwanpur snake was found some distance up into the Churia Hills and not close to water. The Biratnagar specimen was crossing the road right at the edge of Biratnagar town at about 10.00 p.m. The road here was flanked on both sides by standing water.

Bungarus fasciatus (Schneider)

Specimens examined (1). MORANG DIST. : 1 km S. Ithari, 120 m (1), 12 Nov. 1968 : length 1232 mm (4′ ½″).

Remarks. The Banded Krait, not reported from Nepal before (*see* Swan & Leviton 1962 : 141), does not appear to be common here. Our specimen was found early one morning on the Dharan Road where it had been killed trying to cross. On both sides of the road at this point were pools of water. People here recognized the snake but said it was not common.

Calliophis macclellandi (Rheinhardt)

Specimens examined (1). KATHMANDU VALLEY : Swyambu Hill, 1300 m (1), Sept. 1968 : length 482 mm.

Coloration. Dorsally this snake is uniformly light brown with an indistinct vertebral row of black dots ; the head is black with a wide transverse, cream-coloured bar.

Remarks. The Coral Snake has been reported from Nepal but without exact locality data. This very poisonous snake is not common in Nepal and so far our only specimens are from the Kathmandu Valley. Besides the one specimen reported on here we have seen individuals caught on Toka Hill and in the Rabi Bhawan Compound, Kali Mati. The specimen given here is well preserved and displayed in the collection of the Anand Kuti Science College, Kathmandu.

Naja naja (Linnaeus)

Specimens examined (1). MORANG DIST. : Biratnagar Town, 300 m (1), Oct. 1969 : length 615 mm.

Remarks. Although the Common Cobra is frequently seen in lowland Nepal, it has not been reported previously from this country (*see* Swan & Leviton 1962 : 142). The Common Cobra occurs in the Terai and Bhabar, but is apparently less common in the low hills and Duns. Our specimen was caught by Mr. Das, DFO, in the Forest Department Compound situated in the center of Biratnagar Town. Cobras are thought to be fairly common here. We also heard they are common around Dharan where the Town Panchyat has received several hundred individuals after offering bounties. In March 1969 we saw a large, light tan Cobra at the edge of cultivations along the Kosi Embankment Road, Sunsari Dist., but could not secure the specimen.

It is also possible that some Cobras were introduced into the Kathmandu Valley early in the 1900's by a Rana Prime Minister. Rumors persist that Cobras occur at Balaju but these are unsubstantiated.

Ophiophagus hannah (Cantor)

Specimens examined (2). CHITWAN DIST. : 18 km W. Hetaura, 300 m (1), Sept. 1960 ; RAUTAHAT DIST. : 3 km N. Mahendra Rajmarg, *c.* 30 km E. Simra-Amleckganj Rd., 200 m (1), Oct. 1969. Both were approximately 3 m long.

Coloration. Both snakes were very dark brown without yellow chevron markings. The head and foreneck of the Chitwan specimen is now in the collections of the Bombay Natural History Society, Bombay.

Remarks. The King Cobra is not a common snake of Nepal. The Chitwan individual was in tall grass at the edge of forest. It hid under a large log when approached. The Rautahat snake was in dense Sal forest and came towards a jeep in which hunters were riding, whereupon it was shot. This Cobra is a forest snake here in Nepal but is not necessarily found in the hills. The Rautahat Cobra was in Bhabar forest some 10 km from the Churia foothills.

TYPHLOPIDAE

Typhlops braminus (Daudin)

Specimens examined (4). KATHMANDU VALLEY: American Club, Kali Mati (2), TU collection (1), Anand Kuti collection (1).

Remarks. The Common Blind Snake, although fairly common in Kathmandu, has not been reported before from Nepal (*see* Swan & Leviton 1962 : 142). Other specimens have been caught and sent to the Bombay Natural History Society and to The Field Museum, Chicago.

VIPERIDAE

Trimeresurus albolabris Gray

Specimens examined (2). KATHMANDU VALLEY: TU Collection (1); CHITWAN DIST.: 50 km S. Narayanghat, 300 m (1).

Remarks. This Green Pit Viper is not common in Nepal. All previous specimens taken here are from the hills (*see* Swan & Leviton 1962 : 116) but this range should be extended to include at least the lowlands of the Chitwan Dun. Our Chitwan Viper was caught near the edge of a dense heterogenous forest of Sal and other broad-leaved species.

Trimeresurus monticola Günther

Specimens examined (4). KATHMANDU VALLEY: Swyambu Hill (1), Patan Gate (1), Patan City (1); ILAM DIST.: Hake Tham (Jamuna), 2250 m (1), 15 May 1970; weight 68 gm, length 472 mm.

Coloration. These snakes are typically brown with dark brown mottling.

Remarks. The Mountain Pit Viper is the most common poisonous snake in the hills of Nepal. We have seen several individuals from the Kathmandu Valley besides those listed here. These vipers are found in yards and sometimes within houses of Kathmandu. The Patan Gate specimen had grey hair (presumably rat) in the GI tract. All previous records of this species are from central Nepal (*see* Swan & Leviton 1962 : 116), thus our individual from far east Nepal is of interest. Our Hake Tham snake was resting in dense forest under a covering of wet moss and leaves when its head was accidently touched while we were searching for a rare bird's nest. The sluggish snake did not attempt to bite until greatly disturbed.

Trimeresurus stejnegeri Schmidt

Specimens examined (2). KATHMANDU VALLEY : Anand Kuti collection, reportedly from Swyambu Hill (1) ; SINDHU DIST. : Malemchigoan, 2470 m (1).

Coloration and Scalation. Our specimen from Malemchi differs somewhat from the description given by Smith (1943 : 517-518). Our snake has 8 supralabials (as opposed to 9-10, Smith 1943 : 517). Otherwise it is similar to typical *stejnegeri* in that the first labial is completely divided from the nostril ; there are 21 scale rows at mid body ; most of the scales are distinctly keeled ; the temporal scales are smooth ; the right supraocular is divided by a transverse suture, the left only partly so.

The snake is greenish-bluegrey on the dorsal aspect with irregular ferruginous markings on the head and body. These blotches involve single scales on the body, but combine several scales on the head so that irregular lines occur. These brown markings appear to be somewhat similar to those of *T. gramineus* of S. India. There is a pale whitish line of scale row 1 which is not bordered by orange or chocolate (as described for typical *stejnegeri*).

Remarks. Specimens previously collected in Nepal have been from about 4000 feet altitude (*see* Swan & Leviton 1962 : 116). Our Malemchi snake is from *c.* 8100 feet. It was caught on a grassy slope.

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The aquatic and marshland plants of Bundi District, Rajasthan[1]

BY

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The paper gives a detailed account of the aquatic and marshland flora of Bundi district in south-eastern part of Rajasthan. The district has remained botanically unexplored from lack of facilities. The region, apparently unsuitable for the growth of luxuriant vegetation, maintains a rich aquatic and wetland flora. The present study shows that 97 species of vascular plants belonging to 42 families inhabit the lakes, ponds, puddles and marshes in the district.

INTRODUCTION

The flora of Rajasthan has been studied in great detail since the publication of Blatter & Hallberg's (1918-21), 'The Flora of the Indian Desert'. In recent years, studies have also been undertaken on the hydrophytic and wetland flora of the terrain (Ratnam & Joshi 1952 ; Sarup 1958, 1961 ; Nair & Kanodia 1959 ; Vyas 1962 ; Gupta 1966 ; *see* also Biswas & Calder 1937 ; Subramanyam 1962). There is, however, a lacuna in our knowledge of the flora of Bundi district in south-eastern part of Rajasthan. The present paper deals with a detailed floristic survey of the aquatic and marshland plants of the district. The region was surveyed in different seasons during the years 1968 and 1969. Specimens of aquatic and marshland species collected during this study are preserved in the Herbarium of Floristic Botany Division, National Botanic Gardens, Lucknow.

LOCATION AND HABITATS

Bundi district is situated in the south-eastern part of Rajasthan between 24°59′ and 25°59′ N., and 75°18′ and 76°21′ E. It is bounded on the north by Tonk district, on the east by Kota district and on the west

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by Bhilwara district. In the south, it is delimited by Kota and Bhilwara districts. The district occupies an area of 3473 sq. km and is situated at an altitude of 302 m above m.s.l.

The present study was conducted over a greater part of the district, with special reference to the following areas :

1. *Bundi :* The town of Bundi is situated in a narrow and picturesque sandstone gorge. It forms part of the south-eastern plateau of Rajasthan where the Aravallis meet the Vindhyas. The northern part is covered with Aravalli rocks and in the south are the Vindhyas and sedimentary rocks consisting of sandstone and limestone. The soil is deep black and fertile. The area has been provided with a canal system hewn out of the rocks. The hydrophytes and marsh plants are found in places like Bara Talao, Talao Gaon, Shikarburj and in the vicinity of Mangli and Ghodapachad rivers. Besides, there are extensive low-lying areas including paddy fields which support a thick growth of these plants. The artificial lakes like Phool Sagar, Nawal Sagar and Jaith Sagar have only sparse vegetation.
2. *Hindoli :* Hindoli is a small tehsil of Bundi district and is situated at a distance of about 20 km to the north of Bundi on Bundi-Ajmer Road. Besides several ponds and ditches which dry up during the winter and summer months, it includes a large perennial lake occupying an area of about 2 sq. km. This lake supports rich aquatic and marsh vegetation throughout the year. The Mej river flows at a distance of about 8 km in the south-west of the town and is another habitat for the growth of hygrophilous vegetation.
3. *Talera :* Talera is situated at a distance of about 15 km in the western part of Bundi on Kota-Bundi Road. The River Talera and a number of ponds and puddles are the habitat for the hydrophytic vegetation.
4. *Indragarh :* Indragarh is situated at a distance of about 70 km in the north-eastern part of Bundi. It is a low-lying area which gets flooded during the rainy season. In the following months, it is richly covered by a luxuriant vegetation of aquatic and wetland species.
5. *Kishorapatan :* It is situated in the immediate vicinity of Kota district. A number of tanks, ponds and paddy fields support thick growth of aquatic and marsh vegetation.

SOIL AND CLIMATE

The climate of the area is dry monsoonic and shows three well marked seasons, namely rainy, winter and summer seasons. During the months of May and June, the mean maximum temperature of 42·3°C has been recorded. The mean minimum temperature of 6·6°C has been recorded in the months of December and January. Out of the total annual rainfall, the months of July to October receive 750-900 mm of rains which is 99% of the total fall of the year. The rains are infrequent during the winter season. The soil can be broadly classified into clay and clay-loam types. The clay content varies from 25-48%, and shows 25-50% silt and 25-50% sand. The dispersion co-efficient has been found to be very low, thus indicating a good water stable structure and a resistance to detachability by flood water.

PLANT ASSOCIATIONS

The aquatic and marsh vegetation of the district shows a number of associations in different localities and situations. Besides, there are pure communities of *Eichhornia crassipes* (Mart.) Solms, *Nelumbo nucifera* Gaertn., *Pistia stratiotes* Linn., *Potamogeton pectinatus* Linn., *P. perfoliatus* Linn., *Trapa bispinosa* Roxb., and *Typha angustata* Bory & Chaub. in different parts of the district. The present investigation shows that associations of following plants are noticeable in the area :—

1. *Aquatic habitat :* Associations—
    - A. *Zannichellia* — *Hydrilla* — *Ceratophyllum* — *Nymphoides* — *Utricularia* (Hindoli) ;
    - B. *Azolla* — *Spirodela* (Kota-Bundi Road) ;
    - C. *Nymphaea* — *Nymphoides* — *Zannichellia* (Bundi) ;
    - D. *Potamogeton* — *Hydrilla* — *Ceratophyllum* (Talera) ;
    - E. *Nymphaea* — *Hydrilla* (Talab Gaon).
2. *Marshy and wetland habitats :* Associations—
    - A. *Typha* — *Crinum* — *Phragmites* — *Sarcostemma* — *Scirpus* (Talera) ;
    - B. *Bacopa* — *Marsilea* — *Cyperus* (Kota-Bundi Road) ;
    - C. *Phyla* — *Marsilea* — *Eclipta* (Kota-Bundi Road) ;
    - D. *Hygrophila* — *Eclipta* — *Alternanthera* — *Bacopa* (Talera) ;
    - E. *Eriocaulon* — *Cyperus* — *Fimbristylis* (Bundi-Hindoli Road) ;
    - F. *Juncellus* — *Polygonum* (Kota-Bundi Road) ;
    - G. *Monochoria* — *Marsilea* (Bundi-Indragarh Road) ;
    - H. *Ammannia* — *Caesulia* — *Aeschynomene* (Indragarh).

TABLE 1

SHOWING THE HABITAT, FLOWERING PERIOD AND DETAILED DISTRIBUTION OF HYDROPHYTES AND MARSHLAND SPECIES

Species	Habitat	Flowering period	Localities				
			1	2	3	4	5
1. MARSILEACEAE							
Marsilea minuta Linn.	B	Aug.-Oct.	+	+	+	+	+
2. SALVINIACEAE							
Azolla pinnata R. Br.	A		+	+	—	+	+
3. EQUISETACEAE							
Equisetum ramosissimum Desf. subsp. *ramosissimum*	F		—	—	+	—	—
4. NYMPHAEACEAE							
Nelumbo nucifera Gaertn.	B	March-July	—	+	—	—	—
Nymphaea nouchali Burm. f.	B	July-Oct.	+	+	+	—	—
N. stellata Willd.	B	July-Oct.	+	+	—	—	+
5. CRUCIFERAE							
Coronopus didymus (Linn.) Sm.	F	Jan.-March	+	—	—	+	+
6. ELATINACEAE							
Bergia ammanioides Roxb.	F	Oct.-Dec.	—	+	—	—	—
7. STERCULIACEAE							
Melochia corchorifolia Linn.	F	Sept.-Nov.	—	+	—	+	+
8. TILIACEAE							
Corchorus capsularis Linn.	F	July-Sept.	+	+	—	+	+
C. trilocularis Linn.	F	July-Oct.	—	+	—	—	+
9. PAPILIONACEAE							
Aeschynomene indica Linn.	E, F	July-Oct.	+	+	—	—	+
Sesbania bispinosa (Jacq.) W. F. Wight	F, E	Aug.-Oct.	+	+	—	+	+
10. CAESALPINIACEAE							
Cassia tora Linn.	F	July-Sept.	+	+	—	+	+
11. ROSACEAE							
Potentilla supina Linn.	F	Jan.-April	+	+	+	+	+
12. LYTHRACEAE							
Ammannia baccifera Linn.	F	July-Oct.	+	+	+	+	+
A. multiflora Roxb.	F	Aug.-Nov.	+	—	—	—	—
13. ONAGRACEAE							
Ludwigia adscendens (Linn.) Hara syn. *Jussiaea repens* Linn.	A	Aug.-Nov.	+	+	—	+	+
L. octovalvis (Jacq.) Raven subsp. *sessiliflora* (Mich.) Raven syn. *Jussiaea suffruticosa* Linn.	F	Oct.-Jan.	+	+	+	—	+
L. perennis Linn. syn. *L. parviflora* Roxb.	E, F	Aug.-Nov.	+	+	—	+	+

Explanation of symbols :

+ = present ; — = absent ; A = Free-floating ; B = Attached with floating leaves and/or shoots ; C = Suspended submerged ; D = Attached submerged ; E = Aquatic or Amphibious emerged ; F = Wetland ; 1 = Bundi ; 2 = Hindoli ; 3 = Talera ; 4 = Indragarh ; 5 = Kishorapatan.

TABLE 1 (*Contd.*)

Species	Habitat	Flowering period	Localities				
			1	2	3	4	5
14. TRAPACEAE							
Trapa bispinosa Roxb.	A	Sept.-Dec.	+	+	+	+	+
15. MOLLUGINACEAE							
Glinus lotoides Linn.	F	Oct.-Dec.	+	+	—	+	+
16. RUBIACEAE							
Dentella repens (Linn.) Forst.	F	Jan.-March	+	+	—	—	+
17. COMPOSITAE							
Caesulia axillaris Roxb.	E, F	Sept.-Dec.	+	+	+	+	+
Eclipta prostrata (Linn.) Linn.	F	Most part of the year	+	+	+	+	+
Sphaeranthus indicus Linn.	F	Oct.-Feb.	+	+	—	+	+
Gnaphalium indicum Linn.	F	Dec.-March	+	+	+	—	+
Centipeda minima (Linn.) A. Br. & Aschers. syn. *C. orbicularis* Lour.	D, F	Oct.-Feb.	—	+	+	+	—
18. GENTIANACEAE							
Enicostemma hyssopifolium (Willd.) Verdoorn syn. *E. littorale* Bl.	F	July-Nov.	+	—	+	—	+
Hoppea dichotoma Willd.	F	Oct.-Nov.	—	—	+	+	+
19. LIMNANTHACEAE							
Nymphoides cristatum (Roxb.) Ktze.	B	Jan.-March	—	+	+	—	+
N. indicum (Linn.) Ktze.	B	Jan.-March	—	+	+	—	—
20. ASCLEPIADACEAE							
Sarcostemma esculentum (Linn. f.) Holm syn. *Oxystelma esculentum* (Linn. f.) Schult.	F	March-May	—	—	+	—	—
21. BORAGINACEAE							
Heliotropium ovalifolium Forsk.	F	March-May	—	+	—	—	+
22. CONVOLVULACEAE							
Ipomoea aquatica Forsk.	A	Dec.-March	+	+	+	+	+
23. SCROPHULARIACEAE							
Bacopa monniera (Linn.) Pennell	E	Sept.-Dec.	+	+	+	+	+
Limnophila indica (Linn.) Druce	E	Feb.-Apr.	—	—	+	—	—
Lindernia crustacea Muell.	F	Jan.-Mar. & July-Sept.	+	+	+	+	+
L. procumbens (Krock.) Philcox syn. *Vandellia pyxidaria* Maxim.	F	Jan.-Mar.	+	—	+	—	—
Veronica anagallis-aquatica Linn.	E, F	Jan.-Mar.	+	+	+	+	+
Verbascum chinense (Linn.) Sant.	F	Jan.-March	+	+	+	—	+
24. LENTIBULARIACEAE							
Utricularia aurea Lour.	A	Aug.-Jan.	—	+	+	+	—
U. gibba Linn. subsp. *exoleta* (R. Br.) Tayl. syn. *U. exoleta* R .Br.	A	Jan.-Apr.	+	+	—	—	—

TABLE 1 (*Contd.*)

Species	Habitat	Flowering period	Localities				
			1	2	3	4	5
25. ACANTHACEAE							
Hygrophila auriculata (Schumach.) Heine syn. *Asteracantha longifolia* Nees	F	Jan.-Mar.	+	+	+	+	+
Hemiadelphis polyspermus Nees syn. *Hygrophila polysperma* T. Anders.	F	Sept.-Mar.	+	+	+	—	+
Justicia quinqueangularis Koen. ex Roxb.	F	Aug.-Nov.	+	+	+	+	+
26. VERBENACEAE							
Phyla nodiflora (Linn.) Greene	F	Throughout the year	+	+	+	+	+
27. AMARANTHACEAE							
Alternanthera sessilis (Linn.) DC.	F, E	Most part of the year	+	+	+	+	+
A. paronychioides St. Hil.	F	Sept.-Jan.	+	+	—	—	—
Amaranthus tenuifolius Willd.	F	Oct.-Dec.	—	+	—	—	—
28. POLYGONACEAE							
Polygonum barbatum Linn. subsp. *gracile* Danser	E	Aug.-Dec.	+	—	+	—	+
P. glabrum Willd.	E	Aug.-Nov.	+	+	+	+	+
P. plebejum R. Br.	F	Aug.-Nov. & Mar.-June	+	+	+	+	+
Rumex dentatus Linn.	F	Feb.-Apr.	+	+	+	—	—
29. CERATOPHYLLACEAE							
Ceratophyllum demersum Linn.	C	Jul.-Sept.	+	+	+	+	+
30. HYDROCHARITACEAE							
Hydrilla verticillata (Linn. f.) Royle	C	Jul.-Sept.	+	+	+	+	+
Ottelia alismoides (Linn.) Pers.	D	Jan.-Mar.	—	+	+	—	—
Vallisneria spiralis Linn.	D	Feb.-Apr.	+	+	+	—	—
31. AMARYLLIDACEAE							
Crinum defixum Ker-Gawl.	E, F	Most part of the year	+	+	+	+	+
32. PONTEDERIACEAE							
Eichhornia crassipes (Mart.) Solms	A	May-Oct.	+	+	+	+	+
Monochoria vaginalis (Burm. f.) Presl	E, F	Aug.-Oct.	+	+	—	+	+
33. PALMAE							
Phoenix sylvestris (Linn.) Roxb.	F	Mar.-May	+	+	+	—	+
34. TYPHACEAE							
Typha angustata Bory & Chaub.	E	Jul.-Nov.	+	+	+	+	+
35. ARACEAE							
Pistia stratiotes Linn.	A	Apr.-Jun.	—	+	—	—	—
36. LEMNACEAE							
Spirodela polyrrhiza Schleid.	A	Oct.-Jan.	+	+	+	+	+

TABLE 1 (*Contd.*)

Species	Habitat	Flowering period	Localities				
			1	2	3	4	5
37. POTAMOGETONACEAE							
Potamogeton crispus Linn.	D	Feb.–May	+	+	+	+	+
P. pectinatus Linn.	C	Jan.-Mar.	—	—	+	—	—
P. perfoliatus Linn.	D	Feb.-May	—	—	+	—	—
38. ZANNICHELLIACEAE							
Zannichellia palustris Linn.	C	Feb.-Mar.	+	+	+	+	+
39. NAJADACEAE							
Najas marina L. syn. *N. major* All.	C	Sept.-Dec.	—	—	+	—	—
40. ERIOCAULACEAE							
Eriocaulon quinquangulare Linn.	F	Dec.-Apr.	+	+	—	+	+
41. CYPERACEAE							
Eleocharis atropurpurea Kunth	F	Jan.-May	—	+	+	+	—
Fimbristylis bisumbellata (Forst.) Bub. syn. *F. dichotoma* Cl.	F	Aug.-Nov.	+	+	+	+	+
F. aestivalis Vahl	F	Sept.-Dec.	+	—	—	+	—
Cyperus alopecuroides Rottb.	F, E	Aug.-Dec.	+	—	+	—	+
C. compressus Linn.	F	Aug.-Dec.	+	+	+	+	+
C. digitatus Roxb.	E	Jul.-Sept.	+	+	—	—	+
C. difformis Linn.	E	Sept.-Dec.	+	+	+	+	+
C. eleusinoides Kunth	E	Sept.-Nov. & Jan.-Feb.	—	+	+	—	—
C. flavidus Retz.	F	Dec.-Mar.	+	—	—	+	—
C. iria Linn.	F	Aug.-Nov.	+	+	+	+	+
C. pygmaeus Rottb.	F	Jul.-Oct.	+	+	+	+	+
C. pangorei Rottb. syn. *C. tegetum* Roxb.	F	Dec.-Apr.	—	—	+	—	+
C. rotundus Linn.	F	Jul.-Dec.	+	+	+	+	+
Scirpus articulatus Linn.	F	Jan.-May	—	+	—	—	—
S. roylei (Nees) Parker	F	Jul.-Nov.	+	—	—	+	—
S. supinus Linn.	F	Oct.-Dec.	+	+	—	+	+
S. tuberosus Desf.	F, E	Dec.-Mar.	—	—	+	+	—
42. GRAMINEAE							
Arundo donax Linn.	F	Oct.-Dec.	—	—	—	+	—
Coix lachryma-jobi Linn.	E, F	Sept.-Dec.	—	+	+	—	—
Echinochloa colonum (Linn.) Link	F	Jan.-Oct.	+	+	—	+	+
Hygroryza aristata Nees	A	Apr.-June	+	+	—	—	—
Isachne miliacea Roth	E	Nov.-Feb.	—	—	—	+	—
Oryza sativa Linn.	F, E	Oct.-Nov.	+	+	+	+	+
Paspalidium punctatum Stapf	E, F	Sept.-Nov.	+	+	+	—	+
Phragmites maxima Blatt. & McC.	F	Sept.-Jan.	—	+	—	—	—
Vetiveria zizanioides Nash	F	Aug.-Oct.	—	—	—	+	+

DISCUSSION

The area, apparently unsuitable for the growth of luxuriant vegetation, is rich in aquatic and marshland species. The Chambal river passes through the hilly terrain and supports aquatic and marsh vegetation in the ravines. Its tributaries like Talera, Mej and Mangli carry a considerable amount of sand and are favourable spots for the ecesis of hydrophytes. The Hindoli Talao, Talera river and Bara Talao in Bundi are among the important habitats for the growth of aquatic and marsh vegetation.

The present study shows that 97 species of vascular plants inhabit the riverain and wetland areas of the district (Table 1). Of these, 34 species occur in aquatic situations, 51 in marshes and wetlands and the rest, both in aquatic and wetland situations. This paucity of aquatic species may be due to rocky bottom and wide amplitude of water level in puddles and reservoirs. Some species are restricted to a single habitat, e.g. *Equisetum ramosissimum* Desf. subsp. *ramosissimum*, *Nelumbo nucifera* Gaertn., *Bergia ammanioides* Roxb., *Amaranthus tenuifolius* Willd., *Ammannia multiflora* Linn., *Sarcostemma esculentum* (Linn. f.) Holm, *Limnophila indica* Druce, *Potamogeton pectinatus* Linn., *P. perfoliatus* Linn., *Scirpus articulatus* Linn., *Arundo donax* Linn., *Isachne miliacea* Roth, *Phragmites maxima* Blatt. & McC., and *Najas marina* L. Among the species occurring throughout the area may be mentioned *Marsilea minuta* Linn., *Ammannia baccifera* Linn., *Potentilla supina* Linn., *Trapa bispinosa* Roxb., *Caesulia axillaris* Roxb., *Eclipta prostrata* Linn., *Ipomoea aquatica* Forsk., *Bacopa monniera* Pennell, *Lindernia crustacea* Muell., *Veronica anagallis-aquatica* Linn., *Hygrophila auriculata* Heine, *Justicia quinqueangularis* Koen. ex Roxb., *Phyla nodiflora* Greene, *Alternanthera sessilis* DC., *Polygonum glabrum* Willd., *P. plebejum* R. Br., *Ceratophyllum demersum* Linn., *Hydrilla verticillata* Royle, *Crinum defixum* Ker-Gawl., *Eichhornia crassipes* Solms, *Typha angustata* Bory & Chaub., *Spirodela polyrrhiza* Schleid., *Potamogeton crispus* Linn., *Zannichellia palustris* Linn., *Fimbristylis bisumbellata* Bub., *Cyperus difformis* Linn., *C. iria* Linn., *C. pygmaeus* Rottb. and *C. rotundus* Linn.

The following species are rather uncommon in the flora of Rajasthan and have been collected during the course of this study : *Ludwigia perennis* Linn., *Utricularia gibba* Linn. subsp. *exoleta* Tayl., *Ottelia alismoides* (Linn.) Pers., *Cyperus flavidus* Retz., *Cyperus pangorei* Rottb., *Cyperus alopecuroides* Rottb., *Monochoria vaginalis* Presl, *Eleocharis atropurpurea* Kunth, *Amaranthus tenuifolius* Willd. and *Najas marina* L.

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Ecology of the Soft-furred Field Rat, *Rattus meltada meltada* (Gray) in Kolar, Mysore State[1, 5]

BY

R. K. CHANDRAHAS[2] AND A. K. KRISHNASWAMI[3]

INTRODUCTION

Of the ten species of wild rodents encountered in the south Indian plague focus[4] (Chandrahas & Krishnaswami 1971), Soft-furred Field Rat, *Rattus meltada meltada* (Gray) has been found to be widely distributed in good numbers. Krishnaswami *et al.* (1970) reported serological evidence of the presence of plague anti-bodies in this species. Bhatnagar (1966) also recorded plague infection among *M. meltada* in Uttar Pradesh. The species is also considered to cause damage to food crops, especially paddy and has been reported to be a serious pest in cotton fields (Prater 1965). In view of its public health and economic importance attention was focussed on studies on its ecology.

Detailed studies on the ecology of *Rattus m. meltada* in India are relatively few. Ellerman (1961) and Prater (loc. cit.) have described the external characters and habitat of this species. Bindra & Premsagar (1968) reported findings on the breeding of *Millardia meltada* on the basis of laboratory work at Ludhiana. This paper describes the burrowing habit, breeding season, litter size and sex ratio of *Rattus m. meltada* on the basis of the studies undertaken in the neighbourhood of Kolar town, Mysore State.

MATERIAL AND METHODS

Systematic collection of rodents was undertaken at a monthly interval by excavating the burrows from January 1969 to December 1970. Studies were mostly confined to Hodalavadi, Chinnapura and Kolar

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[4] Comprising the adjoining districts of Kolar and Bangalore (Mysore State), Dharmapuri (Tamil Nadu) and Chittoor (Andhra Pradesh).

[5] Accepted February 23, 1972.

Amani Tank localities. The rodents collected from each burrow were kept separately in well ventilated cages. The total number of rodents encountered in each burrow was recorded. The rodents thus collected were anaesthetised in the laboratory, weighed, sexed and dissected for the presence or absence of embryos in females and sperm in males. Sperm smears were drawn from the epididymis and recorded after examining under a microscope by adding a drop of saline over the slide. All the females were dissected irrespective of age and those exhibiting embryos were grouped as gravid.

OBSERVATIONS AND DISCUSSION

Burrows

Rattus m. meltada generally inhabits irrigated fields. Burrows of this species could be readily seen on the bunds bordering irrigated fields. However, some burrows were also encountered in the middle or the fringes of dry fields and in the neighbourhood of fields where wet cultivation is carried out by well water or irrigation channels. After monsoon showers, those living in dry fields take shelter in deserted ant-hills as their burrows get flooded by rain water. *Rattus m. meltada* also frequents village environs as evidenced by their being trapped in villages (Sheshadri—Personal Communication). In the Rajasthan desert also, Prakash (1971) found that *Rattus meltada pallidior* occupies two types of habitat, namely open grasslands and irrigated fields.

The burrow of *Rattus m. meltada* is generally shallow, simple and does not penetrate beyond 30 to 50 cm into the soil. Usually, the main entry is characterised by the presence of more than one opening, of which one is the emergency exit. The emergency exit is covered by grass/hay or combination of both with leaves. The tunnel of the main entry and other openings are completely open without a plug of soil unlike the burrows of *Tatera indica hardwickei.* In some burrows seen in the middle of fallow fields the opening was found to be plugged with the excavated earth. The main tunnel bifurcates into one or two side tunnels. These side tunnels terminate blindly after 15 to 30 cm.

Burrow occupation

During the two year study, 519 burrows of *Rattus m. meltada* were excavated and the number of animals found in each burrow ranged from 1·86 (July) to 4·23 (December), average being 2·69 (Table 1). The average number of animals per burrow was maximum during the period October to January. It was probably because of the higher reproductive activity during this period.

TABLE 1

AVERAGE NUMBER OF *Rattus m. meltada* PER BURROW

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
3·18	2·4	1·88	2·26	2·34	2·25	1·86	1·9	2·7	3·28	4·0	4·23

Male fecundity

No seasonal variation in sexual activity among males was observed. Only 17·0 per cent specimens of the total adult males collected did not exhibit sperms in the epididymal smears. The percentage of fecund males in different months for both the years combined varied from 62·0 to 100·0.

Breeding season

Rattus m. meltada breeds practically throughout the year with a lower intensity during February and March. Pregnant females were encountered in the population throughout except during March 1969, March and April 1970. Likewise, lactating females were not collected during February and April 1969 and March 1970. The reproductive activity was higher from October to January. The percentage of pregnant animals ranged from 25·0 in February to 89·3 in December during 1969 and from 31·2 in July to 84·6 in December during 1970; the annual average being 67·7 and 65·3 per cent respectively for both the years (Table 3). The peak in the reproductive activity could be expected to synchronise with the harvest of the first crop in December. Generally two crops are expected if water in the tanks is found sufficient for the second crop to be harvested in May. Hence, the minor peak in the breeding activity encountered in May 1969 and April and May 1970 could be a synchronisation with the second harvest. Climatic conditions are, however, favourable during October-January period as compared to that in the hotter months. Trapping results in the area has also revealed that *R. rattus* breeds throughout the year[1]. Bindra and Premsagar (1968), however, reported that *M. meltada* litters from March to May and from August to October in Chandigarh. The distribution of pregnancy in *Rattus m. meltada* according to the weight group of pregnant females is summarised in Table 7. It is evident that pregnancy was maximum in the weight group 36-50 gm and minimum in very heavy specimens weighing beyond 81 gm.

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[1] NICD—unpublished.

TABLE 2

AGE AND SEX COMPOSITION OF *Rattus m. meltada* IN VARIOUS MONTHS DURING 1969-1970

Month	1969								1970							
	Adult			Sub-adult			Young	Total	Adult			Sub-adult			Young	Total
	M	F	Per-cent male	M	F	Per-cent male			M	F	Per-cent male	M	F	Per-cent male		
January	12	7	63·0	12	14	46·0	7	52	14	24	37·0	25	18	68·0	26	107
February	8	4	66·6	16	18	47·0	0	46	16	16	50·0	10	15	40·0	20	77
March	6	6	50·0	4	9	30·7	6	31	6	11	35·3	13	16	45·0	0	46
April	12	4	75·0	1	5	16·6	0	22	9	9	50·0	5	5	50·0	20	48
May	9	4	69·0	14	6	70·0	7	40	12	17	41·4	1	4	20·0	35	69
June	6	8	43·0	0	0	0·0	8	22	7	15	32·0	14	18	43·8	21	75
July	7	10	41·0	2	5	28·5	3	27	8	16	33·3	16	20	44·4	8	68
August	10	12	45·4	3	6	33·3	12	43	13	7	65·0	4	6	40·0	18	48
September	12	14	46·0	2	3	40·0	14	45	11	9	55·0	1	3	25·0	15	39
October	4	9	30·7	8	4	66·6	15	40	16	11	59·0	8	9	47·0	21	65
November	12	15	44·4	3	2	60·0	42	74	17	18	48·5	8	9	47·0	26	78
December	16	28	36·3	11	11	50·0	42	108	11	26	29·7	17	22	43·6	53	129
	114	121	48·5	76	83	47·7	156	550	140	179	43·8	122	145	45·7	263	849

M—Male. F—Female.

TABLE 3

NUMBER OF NOT PREGNANT, PREGNANT AND LACTATING FEMALES OF *Rattus m. meltada* AND PREVALENCE OF PREGNANCY DURING THE VARIOUS MONTHS OF THE YEARS 1969-1970

Month	1969						1970					
	Number of females			Total No. of females collected	Per cent pregnant and lactating	Prevalence of pregnancy	Number of females			Total No. of females collected	Per cent pregnant and lactating	Prevalence of pregnancy
	Not pregnant	Pregnant	Lactating				Not pregnant	Pregnant	Lactating			
January	2	4	1	7	71·4	0·71	4	15	5	24	83·3	0·83
February	3	1	0	4	25·0	0·25	10	2	4	16	37·5	0·37
March	4	0	2	6	33·3	0·33	11	0	0	11	0·0	0·0
April	2	2	0	4	50·0	0·50	3	0	6	9	66·6	0·66
May	1	2	1	4	75·0	0·75	3	6	8	17	82·3	0·82
June	5	2	1	8	37·5	0·37	5	5	5	15	66·6	0·66
July	3	6	1	10	70·0	0·70	11	2	3	16	31·2	0·31
August	4	5	3	12	66·6	0·66	2	1	4	7	71·4	0·71
September	5	5	4	14	64·3	0·64	3	3	3	9	66·6	0·66
October	4	2	3	9	55·5	0·55	2	5	4	11	81·8	0·81
November	3	4	8	15	80·0	0·80	4	10	4	18	77·7	0·77
December	3	17	8	28	89·3	0·89	4	13	9	26	84·6	0·84
Annual :	39	50	32	121	67·7	0·67	62	62	55	179	65·3	0·65

TABLE 4

MONTHLY DISTRIBUTION OF WEIGHT CLASSES OF MALE AND FEMALE *Rattus m. meltada* DURING THE YEARS 1969-1970

Sex	Weight classes	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Per cent of total
Male	10- 35 gm	37	26	17	6	15	14	18	7	3	16	11	28	198	43·8
	36- 70 gm	25	21	12	21	20	7	10	22	20	17	25	22	222	49·0
	71-105 gm	1	3	0	0	1	6	5	1	3	3	4	5	32	7·0
	Total :	63	50	29	27	36	27	33	30	26	36	40	55	452	
Female	10- 35 gm	32	33	25	10	10	18	25	12	6	13	11	33	228	43·0
	36- 70 gm	28	19	17	13	22	18	25	18	23	19	30	53	285	54·0
	71-105 gm	3	0	0	0	0	5	1	1	0	1	3	1	15	2·8
	Total :	63	52	42	23	32	41	51	31	29	33	44	87	528	

Litter size

The litter size based on 87 samples of live young dug out from the burrows, ranged from 2-9 ; the average being 4·8 (Table 5). Litters of 3 to 6 comprised 85·0 per cent of the total. Based on their field collections, Bindra & Premsagar (loc. cit.) reported a mean litter size of 6·0 and 5 to 8 young ones in Punjab. Although litters were encountered throughout the year, the period from August to January yielded 56 litters (64·3 per cent). The average number of animals per litter varied from 2·7 in July to 5·6 in November and December. Larger litters were, however, encountered during October-February (ranging from 5·0 to 5·6) and smaller litters were found during March, April and July ranging from 2·7 to 3·3 young. It could be attributed that climatic conditions and availability of food apart from paddy might be largely responsible for the larger litters during the period October-February.

Observations on implanted embryos

Of 112 samples examined, the average size was 5.47 embryos per gravid animal (Table 6). Five and six embryos had the maximum frequency (56·0 per cent). The analysis of the number of embryos encountered during different months indicated that the average number of embryos per female ranged from 3·9 in July to 6·1 in October and generally between 4·8 and 6·1 during the period September to December.

Sex ratio

Of 980 animals both adults and sub-adults collected in both the years, 452 (46·0 per cent) were males, yielding a ratio of one male to 1·16 females. Males comprised 45·84 per cent among adults and 46·47 per cent among sub-adults (Table 2). Study of sex ratio among 269 young ones collected in the field indicated a slight preponderance of males, 50·5 per cent. The gradual decline of males in the population from the young to the adults suggested that males probably suffered from a higher rate of mortality. Sex ratio in various weight groups has been summarised monthwise in Table 4. The percentage of males and females collected in various months according to weight group for both the years is also summarised in Table 4. It is evident that males comprised 46·4 per cent in 10-35 gm and 43·78 per cent among 36-70 gm range. But, in the weight class 71-105 gm males predominated with 68·0 per cent ; indicating greater proportion of males in the higher weight class. It is interesting that the percentage of males in the weight group 36-70 gm was minimum while it was significantly high in the weight group 71-105 gm comprising 68·0 per cent. This could indicate that males might grow faster and the rate of disappearance is more in the weight group 36 to 70 gm than 10-35 gm range. Iyer (1933) who surveyed some localities in Mysore

TABLE 5

DISTRIBUTION OF LITTERS OF VARIOUS SIZES IN THE MONTHLY COLLECTIONS OF *Rattus m. meltada* DURING THE YEARS 1969-1970

Month	Size of litter								Total No. of young ones	Number of lactating females	Average number of young per litter
	2	3	4	5	6	7	8	9			
January	1	1	0	1	0	1	2	0	33	6	5·5
February	0	1	0	1	2	0	0	0	20	4	5·0
March	0	2	0	0	0	0	0	0	6	2	3·0
April	2	0	4	0	0	0	0	0	20	6	3·3
May	0	0	5	3	0	1	0	0	42	9	4·6
June	0	1	2	2	0	0	1	0	29	6	4·8
July	1	3	0	0	0	0	0	0	11	4	2·7
August	0	1	3	3	0	0	0	0	30	7	4·3
September	1	1	3	0	2	0	0	0	29	7	4·1
October	0	1	2	1	1	2	0	0	36	7	5·1
November	0	1	1	4	4	0	1	1	68	12	5·6
December	0	1	0	6	8	2	0	0	95	17	5·6
	5	13	20	21	17	6	4	1	419	87	4·8

TABLE 6

DISTRIBUTION OF LITTERS OF VARIOUS SIZES BY EMBRYO COUNT IN THE MONTHLY COLLECTIONS OF *Rattus m. meltada*

Month	Number of implanted embryos								Total number of embryos	Number of pregnant females	Average number of embryos per pregnant female
	2	3	4	5	6	7	8	9			
January	0	0	3	7	4	4	1	0	107	19	5·6
February	0	0	0	1	2	0	0	0	17	3	5·7
March	0	0	0	0	0	0	0	0	0	0	0·0
April	0	0	2	0	0	0	0	0	8	2	4·0
May	0	0	1	2	2	2	1	0	48	8	6·0
June	0	0	3	1	2	0	1	0	37	7	5·3
July	1	3	2	1	0	1	0	0	31	8	3·9
August	0	0	3	1	0	2	0	0	31	6	5·1
September	0	1	1	5	0	1	0	0	39	8	4·8
October	0	1	0	0	3	2	1	0	43	7	6·1
November	0	0	0	5	6	2	0	1	84	14	6·0
December	0	3	0	11	10	4	2	0	168	30	5·6
Annual :	1	8	15	34	29	18	6	1	613	112	5·47

State observed that the females predominated among live trapped *R. rattus* forming 55·0 per cent.

TABLE 7

DISTRIBUTION OF PREGNANCY BY WEIGHT GROUP OF PREGNANT FEMALES

	Weight range in gm				
	36-50	51-65	66-80	81-95	96 and above
Number of samples	51	40	17	4	0
Per cent :	45·5	35·7	15·0	3·5	0·0

The body weights of 452 males and 528 females of *Rattus m. meltada* were analysed placing them in three groups of 35 gm each. The weight of males ranged from 10 to 102 gm and females from 10 to 85·5 gm. On the basis of laboratory observations, the minimum weight of 10 gm indicated that the animals are about 14-16 days old. The animals grouped under 10-35 gm range are sub-adults in the age group about 6 to 8 weeks. The animals weighing 36-70 gm consist of a mixture of individuals just attained maturity as well as older specimens; and could therefore, be about 10-12 weeks. The weight range of 36-70 gm has the highest frequency among both the males and females.

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Fisheries survey of Himachal Pradesh and some adjacent areas with special reference to trout, mahseer and allied species[1]

BY

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INTRODUCTION

Our knowledge of the fish and fisheries of Himachal Pradesh is very meagre. Menon (1954) listed some of the species of fish while describing 'Fish Geography of Himalayas'. The hill areas of Himachal Pradesh range in elevation from 353 to 6470 metres above sea level. Innumerable streams with clear water traverse the various parts of the State and hold trout, mahseer and other species. The climatic conditions in the State vary from temperate to arctic. Due to varied climatic conditions, the survey was done according to the approachability of a particular part of the State. The survey was undertaken from February to June 1965 and in November 1965. The aims and objective of the survey were (a) to gather data on the position of trout and mahseer fisheries in the hill streams (b) to collect data on hydrobiological conditions of the streams containing trout, mahseer and other species (c) to make inventory of fish species present in the various drainages and to determine their distribution and relative abundance and (d) to assess the total fishing potential by gathering data on fishing methods and gears.

MATERIAL AND METHODS

For survey, important sampling stations on the basis of the number of fishing licences issued for each stream in each district were marked and collections made. Since there are no fish landing or assembly centres in the State, catch composition from each stream was determined by 50 castings done with a cast net of 0·6 cm mesh. The diameter of the net

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when extended by casting was 2·5 m. Small fish and insect life inhabiting the shallow areas of the streams below stones were collected by enclosing one square metre of the substratum with fine square mesh netting cloth and sweeping this area completely. Small fish and insects were collected in the cloth and then picked up. Water samples were analysed according to standard methods of water analysis.

PHYSIOGRAPHICAL FEATURES OF THE DRAINAGE

Himachal Pradesh, in north-west Himalayas, is a hill territory of 28,241 square kilometres and is bounded on the south by Uttar Pradesh and Punjab ; on the north-west by Jammu and Kashmir and on the north-east by Tibet. The State is divided into six districts (Chamba, Mandi, Bilaspur, Mahasu, Kinnaur and Sirmur) for administrative purposes.

The five major rivers which drain the water sheds of the Pradesh are Chenab, Ravi, Beas, Sutlej and Yamuna. Since the Chenab flows only through a short length of Chamba and the area is not accessible it was not included in the survey programme. The region between the water shed of Dhouladhar bordering Kangra Valley and that of Pirpanjal constitutes the Ravi basin. The Ravi is the principal drainage of Chamba district. In its westerly flow, the Ravi receives Sal and Suil streams on the right and Mehla, Chanet and Naini streams on the left banks. The Beas which drains part of Chamba district and the whole of Mandi district has its origin at Beas Kund in Kulu. While flowing in a south-westerly direction the river receives Tirthan, Bakhili, Juni, Suketi and Seon streams on the left and Uhl, Rana, Googli, Bharal, Dehar and Chakki on the right bank. Each of these tributaries in turn receives several side streams forming independent water systems. The Sutlej after flowing through Tibet enters Himachal Pradesh at Shipkila and drains the entire water sheds of Kinnaur, Bilaspur and part of Mahasu district. The principal tributaries are Baspa, Mangla, Gassi, Nogli, Behra, Ali, Ghambar and Ghambrola on the left and Wangad, Barari, Seer and Suker on the right banks. In addition, the Sutlej receives several seasonal streams in Bilaspur district draining the Siwalik hills. The Yamuna which drains the water sheds of Sirmur and partly of Mahasu districts has comparatively few tributaries within Himachal Pradesh. The major ones are River Paber which joins with River Tons near Tiunni in Uttar Pradesh, Tons, Giri, Bata, and Markanda all debouch from the right bank. A complete list of the streams surveyed alongwith places of sampling and approximate elevation is given in Appendix I while the five rivers and their principal tributaries are shown in Fig. 1.

PHYSICO-CHEMICAL CONDITIONS AND INSECT LIFE OF THE STREAMS

(a) *Physico-chemical conditions :*

The study of physico-chemical factors included air and water temperature, pH, dissolved oxygen, total alkalinity, chlorides, silicates, nitrates and phosphates. On the basis of the ecological conditions and physico-chemical factors, the streams have been divided into three categories as described in the following paragraphs and Table I.

(1) ' Trout streams ' are snow fed and situated at an elevation of 1470 metres and above. The other conditions are fast and turbulent currents, forest flora of the surrounding hills mainly of *deodar*, *kail* and *sal* trees and a substratum of boulders and rocks either pitted or smooth.

(2) ' Snow trout streams ' which receive partly snow water and partly spring water flow at elevations ranging from 875 to 1470 metres above sea level. Other features are moderate current forming rapids and pools alternately, hilly forest flora consist mainly of *sal*, pine and bushy plants. The substratum consists of sand, boulders and stones covered with slimy algal matter and moss.

(3) ' Mahseer streams ' which receive spring or rain water are situated at an elevation below 875 metres above sea level. Other features of such streams are slow current forming deep pools at places which sometimes are choked with filamentous algae and submerged vegetation ; forest flora on the surrounding hills consist of pine, *shisham* and thorny bushes ; soil erosion is a great problem and streams carry great quantities of silt during rains. The substratum is composed of pitted rocks and small stones covered with slimy algal matter.

(b) *Insect fauna :*

Insect fauna in the mountain streams depend primarily on the velocity of the current and nature of the substratum (Hora 1936). In the streams where current is swift and the stones of the substratum are bare or covered with algal matter, insect life is largely nymphs of Ephemeroptera and Plecoptera and larvae of Trichoptera, Diptera and Coleoptera in percentages of 67·42, 7·20, 11·40, 7·20 and 6·78 % by number respectively. Important forms of insects inhabiting such streams are *Baetis*, *Epeorus*, *Ephemerella*, *Heptagenia* and *Iron* among Ephemeroptera ; Perlidae among Plecoptera ; *Philopotamus* and *Rhyacophila* among Trichoptera ; Blepharoceridae and Simuliidae among Diptera ; and Haliplidae and Psephenidae among Coleoptera. Distribution of *Baetis* and *Epeorus* and Blepharoceridae is interesting. In Baspa and Paber streams, which show substrata consisting of bare stones and fast current, *Baetis*, *Epeorus* and Blepharoceridae are abundant. On the other hand Uhl river which has pitted rocks and a substratum stones covered with brown, slimy algal matter, the three forms were not abundant. Nymphs of Plecoptera

TABLE I

RANGES OF PHYSICO-CHEMICAL FACTORS AND AVERAGE VALUES FOR CERTAIN TROUT, SNOW TROUT AND MAHSEER STREAMS IN HIMACHAL PRADESH

Type of stream	Number sampled	Air temp. °C	Water temp. °C	pH	Dissolved oxygen in ppm.	Total alkalinity in ppm.	Chlorides in ppm.	Silicates in ppm.
Trout stream	10	12·0-29·0 (20·4)	7·0-16·0 (10·9)	7·5-8·0 (7·7)	10·2-11·8 (11·0)	32·0-48·0 (38·2)	4·0-6·0 (4·6)	0·42-0·56 (0·51)
Snow trout stream	20	15·0-38·0 (24·5)	7·2-20·7 (15·0)	7·2-8·5 (8·0)	8·0-11·2 (9·6)	32·0-68·0 (46·5)	4·0-8·0 (6·6)	0·44-0·59 (0·53)
Mahseer stream	11	20·0-33·0 (25·4)	18·5-25·0 (21·0)	8·3-8·8 (8·6)	7·8-8·4 (8·1)	64·0-88·0 (78·0)	6·0-8·0 (7·1)	0·50-0·61 (0·55)

were abundant in Suil and Andhra streams which have strong current and a substratum of bare stones with algal encrustation.

Insect life of the streams which have moderate current forming pools and rapids alternately consist mainly of the nymphs of Ephemeroptera, Odonata and Plecoptera and larvae of Trichoptera, Diptera and Coleopterain percentages of 38·83, 6·34, 3·53, 28·20, 9·40 and 13·70% respectively by number. In these streams nymphs of Ephemeroptera are represented mainly by *Ephemerella* and *Epeorus*; Odonata by Gomphidae and Agrionidae; Plecoptera by Perilidae and Chloroperlidae; Trichoptera by Leptoceridae and *Rhyacophila*; Diptera by Blepharoceridae, Tipulidae and Simuliidae and Coleoptera by adults and larvae of Dytiscidae and Psephenidae. Nymphs of Odonata have been recorded in maximum number in Suketi, Ali and Ashmi streams. These streams were choked with mats of *Spirogyra* and other aquatic plants like *Hydrilla* and *Potamogeton.*

A complete list of insects and other aquatic animals recorded from the various hill streams is given in appendix II.

FISHING METHODS

The common methods of fishing prevalent in Himachal Pradesh are simple but well-suited to the mountain streams. Fishing methods can broadly be divided into two sub-heads namely (a) nets and (b) other methods.

(a) Nets

The principal types of nets used for fishing in the hill streams are cast net, drag net, gill net and stake net. Since the shape and operation of these nets differ considerably from the conventional types used in the plains, they are briefly described below.

Cast Net

It is a universal gear used for catching small and medium-sized fish. It is known by different names depending on the size of the mesh used. The different names given to this net are ' sorru ' (1·2 cm mesh), 'weru ' (1·8 cm mesh), ' dobajju ' (2·5 cm mesh) and ' palka ' (3 cm mesh). The diameter of the net when extended by casting varies from 1 to 2 metres. A major feature of the net is that solid iron sinkers weighing about 5 kg are fixed to the net on the peripheral cord. On account of heavy sinkers the net settles down immediately at the bottom thus preventing the fish from escaping. As the net after casting settles at the bottom, the fisherman with his feet disturbs the stones which helps in bringing the fish to the pockets of the net. It is generally used for catching *Labeo dero*, *Oreinus plagiostomus, Garra gotyla, Barilius* spp. and yearlings of *Tor putitora.*

Drag net

Drag net or ' Bigha ' or ' Kadh' etc. as it is called locally is generally used to fish in pools of the rivers and their principal tributaries in the lower reaches having moderate current. Its use is limited to dry season when water level in the streams is low. In the rivers it is often employed in shallow pools and places where the river breaks up into several channels. Drag net is always employed in conjunction with stake net. A stake net is fixed across the shallow tail end of the pool. The minimum of 3·0 cm mesh is the common type used in Mandi, and Sirmur. The net is gradually brought downstream from the head end of the pool by a line of men swimming and diving to drive the fish. Heavy sinkers are attached to the lower end of the net so that while being dragged downstream the net remains close to the bottom preventing fish from escaping. As the drag net is brought downstream and approaches the stake net, large number of fishermen with cast net fish the area between the two nets. This method is employed for commercial fishing of *Tor putitora, Labeo dero* and *L. dyocheilus.*

Gill net

It is known as 'Nilotu' or 'Pand'. The minimum permissible mesh is 4·5 cm. It is a kind of gill-cum-wall net fixed across the stream near the head end of the pool having slow current. The net is usually fixed at night with the bottom resting on the bed of the pool. To keep the net in an upright position, small stones and dry grass (Kana) are used as sinkers and floats respectively. The two ends of the net are tied to a tree or boulder on either banks of the stream. During movements the fish gets gilled.

Nylon gill nets are operated in Gobindsagar Lake near Bilaspur by the State Fisheries Department.

Stake net

It is known as ' Bar Patta ' locally. Its operation is limited to certain areas of the main rivers. These nets are operated from August to November. The net with minimum mesh of 3·7 cm is fixed across a stream with stones and perpendicular bamboo stakes. The net near the two banks is kept low in height. Fish which descend down to the river after spawning find their way obstructed and try to escape through the sides near the banks. While doing so, they are caught by number of fishermen with cast nets. This is one of the specific methods used for catching mahseer in descending phase of spawning migration.

(b) Other Methods

Under this sub-head are included rod and line with artificial lures for trout fishing ; long lines with spoon for mahseer fishing ; spear fishing for mahseer and other species. In addition, indiscriminate destruction of young and big fish is done by adopting illegal methods like dynamiting, diversion of water for killing of young fish and poisoning with certain indigenous plants.

FISH FAUNA

During the survey, forty-four species of fish belonging to various orders and families have been collected. Of these four species have been recorded for the first time in Himachal Pradesh. These are *Raimas bola* (Hamilton), *Tor mosal* (Hamilton), *Puntius chagunio* (Hamilton) and *Glyptosternum reticulatum* (McClelland). Table II gives a list of the species, distribution in the State and their general distribution. Certain species have been recorded to prefer particular ecological conditions and are described below.

Barilius bendelisis chedra (Hamilton)

This species was taken from streams with moderate current having substrata of stones covered with slimy algal matter. Temperature tolerance is wide, ranging from 18·5°C to 35·0°C. This species has not been recorded from upper Mahasu and Kinnaur districts where purely snow fed streams occur. Large number of fry have been collected during February-March and June-July. Fertilised eggs have been collected in June from certain streams beneath the pebbles in shallow, slow running areas. The eggs are characterised by the orange colour of the yolk. Its maximum limit of distribution in the State is up to 1180 metres above sea level.

Raimas bola (Hamilton)

R. bola has been collected from a pool in Markanda river at Kala Amb in Sirmur district. This river is seasonal and retains water during the whole year only in some of its deep pools. The pools are covered with filamentous algae and aquatic vegetation. The species was associated with the fry and fingerlings of *B. bendelisis chedra* and *B. barna.*

Tor putitora (Hamilton)

T. putitora or the mahseer inhabits the major rivers of the State and their tributaries situated below 1180 metres m.s.l. excepting River Ravi in Chamba district, though this stretch of the river lies well below the optimum elevation mentioned. This species appears to prefer streams maintaining temperature from 19·5°C to 25·5°C. The water temperature of Ravi system in Chamba district during May-June was 12·5°C to 18·5°C. Fry and fingerlings in thousands have been collected from shallow pools and below big boulders near the shore which are constantly flushed by the main current of the stream throughout the period of the survey. Large-sized fish prefer deep pools of the main rivers and their principal tributaries. In majority of the streams it is associated with *Labeo dero* and *L. dyocheilus* along with several unimportant species.

TABLE II

LIST OF FISHES RECORDED FROM HIMACHAL PRADESH

Sl. No.	Species	Distribution in H.P.	Remarks
		Order CYPRINIFORMES Division Cyprini Sub-Order Cyprinoidei Family CYPRINIDAE Sub-family Rasborinae	
1.	*Barilius barila* (Hamilton)	Bilaspur	Throughout N. India, Bengal, Orissa and Lower Assam.
2.	*Barilius barna* (Hamilton)	Sirmur	Orissa, Bengal and Assam.
3.	*Barilius bendelisis chedra* (Hamilton)	Chamba, Mandi, Bilaspur, Lower Mahasu and Sirmur	Throughout India as far as W. Ghats and Ceylon.
4.	*Raimas bola* (Hamilton)	Sirmur	Orissa, Bengal and Assam.
5.	*Barilius shacra* (Hamilton)	Sirmur	North India and Assam.
6.	*Barilius vagra* (Hamilton)	Chamba, Mandi and Bilaspur	Rivers of Himalayan and sub-Himalayan ranges of N. India and Assam.
		Sub-family Cyprininae	
7.	*Tor mosal* (Hamilton)	Lower Mahasu and Sirmur	Mountain streams of N. India.
8.	*Tor putitora* (Hamilton)	Mandi, Bilaspur, Lower Mahasu and Sirmur	Mountain streams of N. India.
9.	*Puntius chagunio* (Hamilton)	Sirmur	Orissa, Bengal, Assam and N.W. India.
10.	*Puntius conchonius* (Hamilton)	Chamba, Mandi, Bilaspur and Sirmur	From Punjab to Bengal, Southern India, Orissa and Assam.
11.	*Puntius ticto* (Hamilton)	Sirmur	India, Burma, Ceylon and Siam.
12.	*Labeo boga* (Hamilton)	Sirmur	Rivers of Gangetic delta, Madras and Burma.

TABLE II (*contd.*)

Sl. No.	Species	Distribution in H.P.	Remarks
13.	*Labeo dero* (Hamilton)	Chamba, Mandi, Bilaspur and Sirmur	Mountain streams of N. India and Assam.
14.	*Labeo dyocheilus* (McClelland)	Bilaspur	Hills of Punjab and Assam.
15.	*Cyprinus carpio* var. *specularis*	Chamba and Bilaspur	Exotic. Transplanted in Indian waters.
16.	*Cyprinus carpio* var. *communis*	Chamba and Bilaspur	Exotic. Transplanted in Indian waters.
17.	*Garra gotyla* (Gray)	Chamba, Mandi, Bilaspur, Mahasu and Sirmur	Mountain streams of W. Himalayas.
		Sub-family Schizothoracinae	
18.	*Oreinus plagiostomus* (Heckel)	Chamba, Mandi, Bilaspur, Mahasu, Kinnaur and Sirmur	Kashmir, Punjab, Assam and Eastern Himalayas.
19.	*Oreinus sinuatus* (Heckel)	Chamba, Mandi, Bilaspur and Sirmur	Kashmir and Punjab.
20.	*Crossocheilus latius punjabensis* (Hamilton)	Chamba, Mandi, Bilaspur and Sirmur	Hill streams of Punjab and Kashmir.
		Family COBITIDAE	
21.	*Nemachilus botia* (Hamilton)	Mandi	Throughout India (Except Malabar and Ceylon).
22.	*Nemachilus botia aureus* (Hamilton)	Mandi, Bilaspur and Sirmur	Throughout India (Except Malabar and Ceylon).
23.	*Nemachilus corica* (Hamilton)	Chamba, Mandi and Mahasu	Bengal, Punjab and Assam.
24.	*Nemachilus kangrae* Menon	Mandi and Bilaspur	Kangra Valley.
25.	*Nemachilus montanus* (McClelland)	Chamba	All along Himalayas.
26.	*Nemachilus rupicola* (McClelland)	Sirmur	All along Himalayas.
27.	*Nemachilus* sp.	Bilaspur	—
28.	*Nemachilus* sp.	Mahasu	—
29.	*Nemachilus* sp.	Mahasu	—
		Sub-family Botinae	
30.	*Botia birdi* Chaudhuri	Bilaspur	Punjab, Himalayas, Gangetic valley and Assam.
		Sub-family Cobitinae	
31.	*Lepidocephalus guntea* (Hamilton)	Chamba	Punjab, Bengal and Assam.
		Division Siluri Sub-order Siluroidei Family SILURIDAE	
32.	*Wallago attu* (Bloch and Schneider)	Sirmur	India, Burma and Ceylon.

TABLE II (*contd.*)

Sl. No.	Species	Distribution in H. P.	Remarks
		Family AMBLYCIPITIDAE	
33.	*Amblyceps mangois* (Blyth)	Mandi	Satpura-Vindhya ranges along the base of the Himalayas as far as Kangra Valley, Burma and Malaya.
		Family BAGRIDAE	
34.	*Mystus* (*Osteobagrus*) *aor* (Hamilton)	Bilaspur	Punjab, Delhi, U.P., Bengal and Burma.
35.	*Mystus* (*Osteobagrus*) *seenghala* (Sykes)	Bilaspur	Punjab, Delhi, U.P., Bengal and Burma.
		Family SISORIDAE	
36.	*Bagarius bagarius* (Hamilton)	Sirmur	Large rivers of India and Burma.
37.	*Glyptosternum reticulatum* (McClelland)	Chamba	Head waters of Indus, Kabul rivers, eastern Tibet and Sikkim.
38.	*Glyptothorax conirostres* (Steind)	Chamba, Mandi, Bilaspur and Mahasu	Himalayas from Kangra to Simla.
39.	*Glyptothorax pectinopterus* (Hamilton)	Chamba, Bilaspur and Mahasu	Punjab and U.P.
40.	*Glyptothorax stoliczkae* (Steind)	Chamba and Mahasu	Simla and Western Himalayas.
		Order OPHICEPHALIFORMES	
		Family CHANNIDAE	
41.	*Channa gachua* (Hamilton)	Mandi	India, Burma, Ceylon and the Andaman.
42.	*Channa marulius* (Hamilton)	Sirmur	Throughout India and Ceylon.
		Order MASTOCEMBELIFORMES	
		Family MASTOCEMBELIDAE	
43.	*Mastocembelus armatus* (Lacépedé)	Bilaspur	India, Burma and further east.
		Order SALMONIFORMES	
		Family SALMONIDAE	
44.	*Salmo trutta fario* Linnaeus	Mandi, Mahasu and Kinnaur	Exotic. Transplanted in the cold waters of Punjab, Himachal Pradesh and Kashmir.

Oreinus plagiostomus (Heckel)

This is the only indigenous species which thrives in the ice cold waters of trout streams at high altitudes. They have been collected with some exceptions from areas having elevation ranging from 1180 to 3000 metres m.s.l. The species has been collected in River Ravi during May at

Bhasoli and Thein, the places situated at an elevation of 500 metres m.s.l. The temperature tolerance of *O. plagiostomus* ranged from 8·0°C to 22·0°C. The occurrence of this species at Bhasoli and Thein may be on account of low water temperature (12·5°C-18·5°C). Fertilised eggs are of yellow to orange colour and have been collected at different periods in the various river systems. In Sutlej and Beas systems in Mandi and Bilaspur regions fertilised eggs have been collected in March. On the other hand in Sutlej system in Mahasu and Kinnaur districts and Ravi system in Chamba district, fertilised eggs have been collected from May to June. In general, the spawning grounds of *O. plagiostomus* have been located not in the main rivers but in the tributaries with temperature between 18·5°C and 21·5°C.

FISHERIES

Commercial catches of fish in Himachal Pradesh are entirely lacking on account of three main factors. Firstly, the hill streams are shallow and do not hold enough water excepting in some of the deeper pools during the year so as to facilitate the holding of large-sized fish. In the main rivers, conditions are somewhat better but due to strong current and very deep pools, fishing gears are not effective. Secondly, the permanent inhabitants of the hill streams are species which do not grow to large size and it is they which constitute the bulk of the catches. The average catch does not exceed 2 kg per net provided the fisherman work for at least 4 hours. Thirdly, due to difficult hilly terrain and lack of communication it is impossible for the professional fishermen to assemble their catches at a fixed place for disposal. They sell their catches individually. In the whole of Himachal Pradesh there are no fish assembly or marketing centres. Four types of fishery have been recognised in the State as described below.

(a) Trout Fishery

Trout fishery in the streams is constituted only by brown trout, *Salmo trutta fario* Linnaeus though rainbow trout, *Salmo gairdeneri* Richardson has recently been introduced at Barot Trout Hatchery. There are two trout farms in the State at Barot and Chirgaon in addition to a few hatching troughs at Sangla. Regular stocking of the streams is done every year with the fry and fingerlings grown in the two farms. Introduction of brown trout in Himachal Pradesh dates back to 1916 when eyed-ova from Kulu were transplanted in Uhl valley. Independently, eyed-ova from Kulu were transplanted to a small hatchery near Chamba at Siran Ghat in 1910. From Uhl valley, trout was further transplanted in Paber and Baspa streams. Since then trout has established itself very well excepting in Chamba. The trout fishery in Chamba perished after the devastating floods of 1947 in the Ravi. The old revenue records of the former princely State of Chamba reveal a flourishing trout fishery in Ravi till 1947 and fish up to 3 kg had been recorded. At present fish up to 3 kg in some of the best trout streams of the State is rare. The normal weight does not exceed 1·5 kg as revealed by anglers records. Efforts are being made by the State Fisheries Department to explore new areas of the State for development of trout fishery to attract more tourists.

(b) Snow trout Fishery

Snow trout fishery covers the species *Oreinus plagiostomus* and *O. sinuatus*. The two species account for the major catches in Chamba, Mahasu, Kinnaur and parts of Mandi and Bilaspur districts. Good quantity of the two species is caught in the Ravi from Chamba to downstream as far as Bhasoli (Jammu Province) ; in the Sutlej and its main tributaries from Kalpa to the tail end of Gobind-sagar reservoir ; in the Beas and its principal tributaries between Aut and Mandi town and in the Yamuna and its tributaries including Paber, Tons, and Amlawa (U.P.). *O. plagiostomus* measuring 47 cm in length and weighing 1·4 kg has been taken by cast net at Seema in Paber river.

(c) Mahseer Fishery

Tor putitora is the only species giving commercial catches in the State. It forms a good fishery in the main rivers and their tributaries at lower elevations. In Ravi, as mentioned earlier, no trace of existence of mahseer fishery upstream of Madhopur Head Works has been recorded. It may probably be on account of two factors, firstly the water temperature above the barrage is low and secondly on account of barrage which may be an hindrance in the migration of this species. Good mahseer fishery below the barrage has been noted by Sehgal, Shukla and Shah (unpublished) in Gurdaspur district of Punjab. Important streams having mahseer in substantial quantity are the Beas from Aut to Sanghol and its principal tributaries Suketi, Seon, Bharal, Dehar and Chakki ; the Sutlej (Gobind Sagar Lake) and its principal tributaries Gambhar, Gambhrola, Ali, Seer and Suker and the Yamuna between Kalsi (U.P.) and Paonta and its tributaries Giri, Bata and Markanda. Major mahseer fishing centres are Mandi, Sanghol, Ghumarwin, Bilaspur, Dadahu and Paonta.

Mahseer being a migratory fish ascends regularly from the main rivers to the tributaries for spawning in monsoon months and descends back before the onset of winter. Fish weighing upto 3 kg are generally caught in the pools of some of the major tributaries. Fish weighing more than 3 kg are caught in the rivers.

(d) Miscellaneous Fishery

Several small-sized species like *Labeo dero*, *L. dyocheilus*, *Garra gotyla*, *Barilius* spp. etc. constitute this category of hill fisheries. *L. dero* and *L. dyocheilus* rarely exceed 20 cm in total length and constitute the main catches in the tributaries.

CONCLUSIONS

1. Physico-chemical conditions of the mountain streams at higher elevations are characterised by low water temperature, pH close to neutral point, high value of dissolved oxygen and low value of silicates. Trout and *Oreinus plagiostomus* are the species thriving in such streams. Insect life is also specialised and best suited to the swift running waters. Algae and other aquatic vegetation are scanty. The mountain streams at lower elevations on the other hand have higher water temperature, alkaline pH, higher values of total alkalinity and silicates. Such streams contain different types of insects, fish and other aquatic animals.

Trout waters in Himachal Pradesh, at present, are confined only to a few areas in the State. Possibilities of exploitation of new areas in Himachal Pradesh are many. For instance in Chamba district alone Sal and Suil along with their main side streams are some of the streams which afford suitable conditions for transplantation of trout. The analysis of physico-chemical factors and insect life has shown that the conditions are more or less similar to the typical trout streams of the State. These streams are very rich in *Oreinus plagiostomus* of all sizes.

3. Mahseer fishery needs an immediate protection. Destructive methods of fishing like dynamiting, poisoning and diversion of water for catching fish are some of the important factors responsible for decline in mahseer fishery. Even the sanctuaries have not been spared from these destructive methods. In the tributaries, juveniles need full protection, when water level goes low in summer months. To protect them from poaching, certain artificial pools need to be created. Fishing should be prohibited during spawning migration. Some of the deepest pools in the principal tributaries need to be declared as protected and reserved waters. Mass killing of mahseer during migratory phase has adverse impact on the mahseer fishery of the Beas and the Sutlej at Amritsar, Ferozepore, Harike, Ludhiana and Jullunder. The mahseer fishery as per Punjab Fisheries data, in these areas, have declined from 3·57% in the total catch during 1961 to 0·67% in 1965. As mahseer affords an excellent sport even better than trout, adequate conservation measures are necessary.

Cultural possibilities of common carp in the hills of Himachal Pradesh needs further exploration particularly in impounded waters.

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APPENDIX I

TABLE GIVING THE LIST OF TROUT, SNOW TROUT AND MAHSEER STREAMS SURVEYED IN HIMACHAL PRADESH ALONG WITH THE ACTUAL PLACES OF SAMPLING AND ELEVATION (A.S.L.)

Name of the stream	Places of sampling	Approximate elevation (A.S.L.) in feet
	TROUT	
River Uhl	Kamand	4000
River Tirthan	Larji	3500
Sainj Nala	Larji	3500
Chiuntha Khad	Siduan	6000
Kakri Gad	Mangloar	5500
River Paber	Rohru, Seema and Chirgaon	4735, 5500 and 6500
Andhra Khad	Chirgaon	6500
Gumma Khad	Gumma	7000
River Baspa	Sangla	8000
Hurba Khad	Sangla	8000
Rukti Khad	upstream of Karcham— Sangla mule tract bridge	8300
	SNOW TROUT	
Bajgar Khad	Chauntra	3650
Googli Khad	Jogindernagar	4500
Rana Khad	Jalaru	3615
Narla Khad	Saned	4320
River Beas	Mandi	2930
River Beas	Pandoh and Aut	2535 and 3500
Juni Khad	Pandoh	2750
Bhakhili Khad	Bakhili	2750
River Sutlej	Deher, Badi and Slapper	1700, 1700 and 1950
Barari Khad	Badi	1700
Naini Khad	Naini	4200
River Ravi	Parol, Chamba and Mehla	2650, 3072 and 3125
Chanet Khad	Bhanot	3200
Hul Nala	Andraru	4150
Sal Nala	Chamba and Saho	3072 and 4900
River Suil	Sundla, Salooni and Bhandel	2750, 5000 and 5750
Dhaji Nala	Bandel	5800
Dagori Nala	Dagori	5800
Sangnedh Nala	Sangnedh	6500
Sundla Khad	Sundla	2750
Gunnu Nala	Gunnu	3000
Kalhel Nala	Kalhel	4230

APPENDIX I (contd.)

Name of the stream	Places of sampling	Approximate elevation (A.S.L.) (in feet)
Baledh or Chanju Nala	Tissa	4000
River Ravi	Thein and Bhasoli (Jammu Province)	1875
River Ghambar	Sabathu	3500
Shikri Khad	Rohru	4735
Pejah Khad	Masli	5300
Prahat Khad	Prahat	4000
River Tons	Jiunni and Jalalia (Uttar Pradesh)	3010
River Paber	Sharan (Uttar Pradesh)	3010
Ante Khad	Ante (Uttar Pradesh)	3000
Swari Nala	Luri	3000
River Sutlej	Nogli and Luri	2700 and 3000
Nogli Khad	Nogli	2700
Amlawa Khad	Sahiya	3500
	MAHSEER	
River Beas	Ulh snd Mandi	2535 and 2930
Suketi Khad	Chamara	2500
Gangli Khad	Sundernagar	3000
Maihsera Khad	Galma	1800
Seon Khad	Jamsari	2000
Jabothi Khad	Jabothi	2000
Seer Khad	Lower Bambla and Ghumarwin	1800 and 2000
Suker Khad	Bhalu	1750
Sarahali Khad	Deslehra	1500
Alsed Khad	Bhubana	2480
Ali Khad	Ghaggas	2000
Ghambrola Khad	Ghambrola	2030
Ghambar Khad	Ghambar	2250
Hubardi Khad	Chamba-Chuari Road	2000
Chakki Khad	Lahru	1875
Kunhi Khad	Gannra	3500
River Ashmi	Junga	3000
River Giri	Mandi, Rampur (Uttar Pradesh), Dadahu, Sainj and Chaila.	1500, 1800, 2500 and 2517
River Yamuna	Paonta and Kalsi	1538 and 1708

APPENDIX II

LIST OF INSECT AND OTHER AQUATIC ANIMALS GENERA RECORDED FROM HILL STREAMS OF HIMACHAL PRADESH

1. **Trout streams**

EPHEMEROPTERA (Nymphs)
- *Baetis*
- *Ephemerella*
- *Epeorus*
- *Iron*

ODONATA (Nymphs)
- Gomphidae

PLECOPTERA (Nymphs)
- Chloroperlidae
- Perlidae

TRICHOPTERA (Larvae)
- *Philopotamus*
- *Rhyacophila*

HEMIPTERA (Adults)
- *Gerris*

COLEOPTERA (Larvae and Adults)
- Psephenidae (larvae)
- Gyrinidae (adults and larvae)

DIPTERA
- Blepharoceridae
- Chironomidae
- Leptidae
- Simuliidae

MOLLUSCA
- *Planorbis*

2. **Snow trout streams**

TURBELLARIA : TRICLADIDA
- Dendrocoelidae
- Planariidae

NEMATODA
- Unidentifiable forms of nematodes

EPHEMEROPTERA (Nymphs)
- *Baetis*
- *Epeorus*
- *Ephemerella*
- *Heptagenia*
- *Iron*

ODONATA (Nymphs)
- Agrionidae
- Cordulegastridae
- Gomphidae

PLECOPTERA (Nymphs)
- Chloroperlidae
- Perlidae

TRICHOPTERA (Larvae)
- *Philopotamus*
- *Rhyacophila*
- *Hydropsyche*

COLEOPTERA (Adults and Larvae)
- Dytiscidae (Adults)
- Gyrinidae
- Haliplidae

DIPTERA (Larvae)
- Blepharoceridae
- Leptidae
- Simuliidae
- Tipulidae

DECAPODA
- Unidentified species of crab

3. **Mahseer streams**

EPHEMEROPTERA (Nymphs)
- *Baetis*
- *Ephemerella*
- *Epeorus*
- *Heptagenia*
- *Iron*

ODONATA (Nymphs)
- Agrionidae
- Calopterygidae
- Gomphidae
- Lestidae
- Libellulidae

PLECOPTERA (Nymphs)
- Chloroperlidae
- Perlidae

TRICHOPTERA (Larvae)
- *Philopotamus*
- *Rhyacophila*
- *Hydropsyche*

HEMIPTERA (Adults)
- *Corixa*
- *Gerris*
- *Nepa*

COLEOPTERA (Adults and Larvae)
- *Berosus* (adults)
- Dytiscidae (adults and larvae)
- *Gyrinus* (adults and larvae)
- Psephenidae (larvae)

DIPTERA (Larvae)
- Blepharoceridae
- Chironomidae
- Leptidae
- Tipulidae

DECAPODA
- Unidentified species of crab

MOLLUSCA
- *Corbicula*
- *Limnaea*

A study on the Bionomics of *Chauliops fallax* Scott (Heteroptera : Lygaeidae) at Sehore (Madhya Pradesh)[1]

BY

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Phaseolus aureus ('*Moong*') and *P. mungo* ('*Urid*') are widely cultivated pulse crops in India. Among their various insect pests, *Chauliops fallax* Scott was noted to be the most important one at Sehore by the senior author during 1963 and 1964 and was subsequently also recorded feeding on these crops from Indore and Seoni districts in Madhya Pradesh. This is the first record of its occurrence and economic damage to these pulses in India. Distant (1904) gave a brief account of its characteristics, distribution and damage. He reported its distribution only in Ceylon and Japan. Young (1960) reported its occurrence in Western Hunan (China) and studied its biology during 1957-58. Schwarz (1927) and Van Der Goot (1928, 1929) reported an allied species *C. bisontula* Banks as the most important pest of green manure plant in Dutch East Indies. An earlier report (Fletcher 1919) records its occurrence and damage to Soybeans in Kumaon, U.P., in India.

MATERIALS AND METHODS

Mass collections of nymphs were made from the fields in July-August for rearing in laboratory. The adults reared in laboratory and the copulating pairs collected from the fields were confined in glass jars on potted plants to record oviposition, longevity etc. Freshly hatched nymphs were reared singly on tender leaves of host plants in petridishes to study the life history. The average monthly minimum and maximum room temperature during the course of studies (July to October) ranged between 28·3 to 30·8°C and 30·5 to 33·3°C, respectively, while the relative humidity ranged from 68 to 86 per cent. The incidence of the pest was recorded at 10 days interval on 50 randomly selected and tagged plants.

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[1] Accepted November 11, 1968.

RESULTS AND DISCUSSION

Host Plants :

Previously, the pest has been reported feeding only on *Dolichos unguiculata* in Ceylon (Distant 1904) and on soybean in Western Hunan (China) (Young 1960) and India (Fletcher 1919). During the course of present study the pest was mostly found feeding on ' *Moong* ' and ' *Urid* '. It was also occasionally observed on soybean, cowpea and ' moth bean ' (*Phaseolus acontifolius*) ; the lesser suitability of these plants was also found in laboratory due to higher mortality of young nymphs when reared on them. All these plants, except soybean, are the new host records of the pest.

Nature and extent of damage and seasonal incidence :

Both nymphs and adults suck the cell sap from the leaves and tender shoots. Badly damaged leaves show several minute whitish spots caused by feeding and small black pustules formed by the dried up excreta of the pest. The attacked leaves gradually wither due to drain of sap and subsequently fall off the plants. The badly infested plants thus lose all leaves and die prematurely. The severity of damage was maximum on ' *Moong* ' and ' *Urid* ' during August-September when more than 75% plants were infested and more than 50% leaves fell off the attacked plants.

The data on the seasonal incidence of the pest are given in Table 1. The pest was active from second week of July to third week of October. The incidence was at its peak during August-September, when up to 45 nymphs and 12 adults were recorded per plant and up to 20 nymphs and 7 adults per leaf.

TABLE 1

SEASONAL INCIDENCE OF *C. fallax*

Date of Observation	Average population per plant	
	Nymphs	Adults
11.vii.1964	Nil	1·0
21.vii.1964	Nil	1·0
31.vii.1964	4·4	2·5
10.viii.1964	12·5	2·5
20.viii.1964	17·5	6·8
30.viii.1964	18·5	7·5
9.ix.1964	15·5	7·0
19.ix.1964	10·5	6·5
29.ix.1964	7·5	6·0
9. x.1964	3·5	5·0
19.x.1964	Nil	1·0

Life history and description of Stages :

Mating : Mating occurred freely in the field but failed to occur in confinement. Copulating pairs were observed in the field any time during day but mostly during morning and evening. The time taken in mating varied from 100 to 135 minutes, with an average of 118 minutes.

Oviposition : Eggs are laid singly attached to the plant hairs on leaves and tender shoots, but mostly on the basal part of the lower surface of leaves, during night as well as day. The female first exudes a darkish fluid on a plant hair and then deposits an egg on it. The fluid soon dries up thus keeping the egg attached to the hair. When copulating pairs were collected from the field and confined on potted plants, only 4 to 8 eggs were laid per female in one or two days after which oviposition stopped.

Egg : The freshly laid egg is smooth and shining. Light brown in colour later changing to dark brown. It is oval in shape, measuring about 0·63 × 0·31 mm with a slight convexity on one side and the corresponding slight concavity on the other side. Incubation period, during August, ranged from 8 to 10 days (average 9·1 days) and the egg viability ranged from 50 to 75% (average 64.8%).

Hatching occurs during night as well as day, but mostly during night. While hatching, the lid at the anterior end of the egg is pushed open by the nymph but it remains partly attached to the egg shell. Through this opening, the nymph first protrudes its head and then gradually wriggles out completely.

Nymph : The nymphs undergo five moults to reach the adult stage. After hatching, the tiny young pinkish red nymphs are often found in groups up to 3rd instar on the basal part of the undersurface of leaves. The older nymphs subsequently get dispersed. The average durations of 1st to 5th nymphal instars and total nymphal period, during August-September, were 3·15, 3·75, 3·95, 4·15, 5·30 and 20·30 days, respectively with slight variation in different weeks.

First instar : It is oval in shape and measures about 0·66×0·28 mm in the beginning, later increasing to about 0·72 × 0·39 mm. The freshly hatched nymph is shiny light pinkish red. Later, the general body colour deepens to dark pinkish red, while the thorax and basal part of abdomen turn dark brown dorsally. Minute clubbed hairs, borne on slightly raised tubercles, are distributed all over the dorsal side of the body and head. The hairs on the legs and 3rd and 4th antennal segments are, however, simple and unclubbed. The 1st and 2nd antennal segments are reddish, while the 3rd and 4th segments are whitish. The coxae and femora are red ; the remaining parts of the legs are pale whitish. Tarsi are two-segmented. Paired lateral claws are small, curved and dark brown.

Second instar : Measures about 0·86 × 0·41 mm, later increasing to 1·08 × 0·72 mm. The freshly moulted nymph is light pinkish with a yellowish tinge along the lateral margins of the abdomen. Later, the colour becomes reddish brown. The 1st, 2nd and distal part of the 4th antennal segments and the proximal parts of legs up to the basal part of tibiae are reddish brown ; the remaining parts are light yellowish.

Third instar : Measures about 1·23 × 0·78 mm, later increasing to 1·44 × 0·84 mm. The parts having reddish brown colour in the second instar become dark brown in this instar. Lateral abdominal margins are pale yellowish and there is a transverse narrow pinkish band on either side of the dorsum of each abdominal segment.

Fourth instar : Measures about 1·50 × 0·86 mm, later increasing to 1·80 × 0·95 mm. The body colour is similar to that of third instar. Small triangular wing lobes appear in this instar. Ventrally, there are two dark circular raised spots on each abdominal segment.

Fifth instar : Measures about 1·84 × 1·00 mm, later increasing to 2·41 × 1·08 mm. The dark brown wing lobes now extend up to the middle of the abdomen.

Ecdysis : A few hours before each ecdysis the nymph stops feeding and its colour becomes somewhat dull. The old cuticle ruptures along the mid-dorsal region of the thorax and through the rupture the thoracic region of the next instar protrudes out. The legs, head and abdomen are then gradually extricated out of the old cuticle by the bending movements. Within half an hour the process of ecdysis is completed and the exuviae is completely shed. Just after ecdysis the nymph is sluggish and pale but after sometime it becomes active and darker in colour.

Adult : The adult is elongate, oval. The female measures about 2·59 × 1·26 mm and the male 2·50 × 1·08 mm. The females are dark brown whereas the males are pale brownish. The body is slightly constricted at the junction of the thorax and abdomen on either side and bears minute whitish mealy patches and minute filamentous hairs, arising from slightly raised tubercles. The head is broad and cone-shaped with dark stylated compound eyes and 4-segmented antennae. The rostrum is pale brownish, 4-segmented and elongate.

Total life cycle : The total life cycle from egg to adult, during August-September (average temperature 30°C to 33·3°C), varied from 27 to 31 days. This is in conformity with the findings of Young (1960), who reported the length of one life cycle as 33 days at 24-26°C.

Sex-ratio and longevity: Based on the examination of 70 adults that emerged in laboratory rearing, the average ratio of females to males was found to be 1·5 : 1.

The longevity of adult males and females varied from 20 to 28 days (average 24·4 days) and 24 to 30 days (average 27·6 days), respectively.

ACKNOWLEDGEMENTS

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Blenniid fishes from Godavari Estuary[1]

BY

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(*With five text-figures*)

The lower reaches of Godavari estuary, with a vast net-work of creeks, support a rich mangrove vegetation composed of species of *Avicennia*, *Excoecaria*, *Ceriops*, etc. Due to constant tidal action and the consequent erosion of the banks of creeks, the roots of these plants towards the water are generally exposed. Part of the stems and exposed roots were generally infested with wood boring organisms mainly *Teredo* and *Bankia* (Ganapati & Rao 1959). The extent of damage done in some cases is so great that the entire stem appears like a sieve, some of the holes measuring from about 300 mm to 500 mm in length and 5 mm to 50 mm in diameter. In the course of investigations on the fish fauna of these creeks, blenniids were observed for the first time to inhabit the bores vacated by molluscan borers (Dutt & Rao 1961). It is also possible that these blenniids might occupy the bores after eating away the original inhabitants. Prompted by this possibility, an extensive survey of all creeks in the estuary was carried out during which blenniids were collected from mangrove plants of all the creeks. It is interesting to note that these fishes, in spite of intensive search, could not be collected outside the mangrove plants in any part of the estuary.

Blenniids of Godavari estuary fall under two genera represented by five species. All the five have restricted gill openings (Smith 1959) and can be identified by the following key. (The new species is described in detail.)

KEY FOR THE IDENTIFICATION OF GODAVARI BLENNIIDS

1. Gill openings entirely above pectoral base.......... *Omobranchus* Swainson
    (i) Lower canines twice the upper :
        (*a*) Membrane from the last ray of dorsal and anal reaches base of caudal, 9-10 incomplete vertical bars on sides in upper half, 7-8 round spots along mid side, first dorsal edge black, no spots.. *O. bhattacharyae* (Chaud.)

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[1] Accepted July 18, 1970.

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(*b*) Membrane from the last ray of dorsal and anal does not reach caudal base, no markings on sides of body, two dark blotches on 1st dorsal ....*O. bipunctatus* (Day)

(ii) Lower canines about 1½ the upper: Upper half of sides with about 11 broken vertical bands, horizontal lines in the lower half, a dark band along the middle of entire dorsal, a black spot of the size of eye above gill openings..............................*O. japonicus* (Bleeker)

2. Lower edge of gill openings opposite pectoral base.......... *Cruantus* Smith

(i) Ventral much shorter than head ; males with a crest and tentacle on head, sides with 9-10 dark vertical bands, horse-shoe-shaped black ring behind eye, a dark oblique blotch anteriorly on first dorsal.................. ....*C. smithi* sp. nov.

(ii) Ventrals as long as head : no crest and tentacle on head, a short white and black band behind eye, sides with a double row of spots below base of dorsal and a single row along middle, a round black spot posteriorly on dorsal in males............................*C. dealmeida* (Smith)

Some features are common to all the five species. The presence of pores and their arrangement on snout, around eye and from above gill openings to lower jaw across the preopercular margin is more or less same (Fig. 1, A, B.). All the species exhibit sexual dimorphism in the nature of anal fin rays, the tips of which in males develop fleshy spade-like expansions mounted on fleshy bases (Fig. 4, B). This modification becomes apparent in maturing males being more pronounced in fully mature specimens. The anal papilla is very well developed in females while it is simple in males (Fig. 4, A, C) ; the first and shortest anal ray is attached to the anal papilla and appears as if extending out of it in females while it is free from the anal papilla in males. The shape and arrangement of teeth is same in all the species. All the species have dark vertical bands on head, however, the number and position of these bands vary from species to species. There are downward flaps on both lips at the corners of mouth in all the species, those on the upper jaw covering the junction of both lips.

Omobranchus bhattacharyae (Chaud.)

Many specimens ranging from 20 mm to 72 mm total length.

This species occurs in good numbers in the mangroves of the lower reaches and is rarely found in the middle reaches.

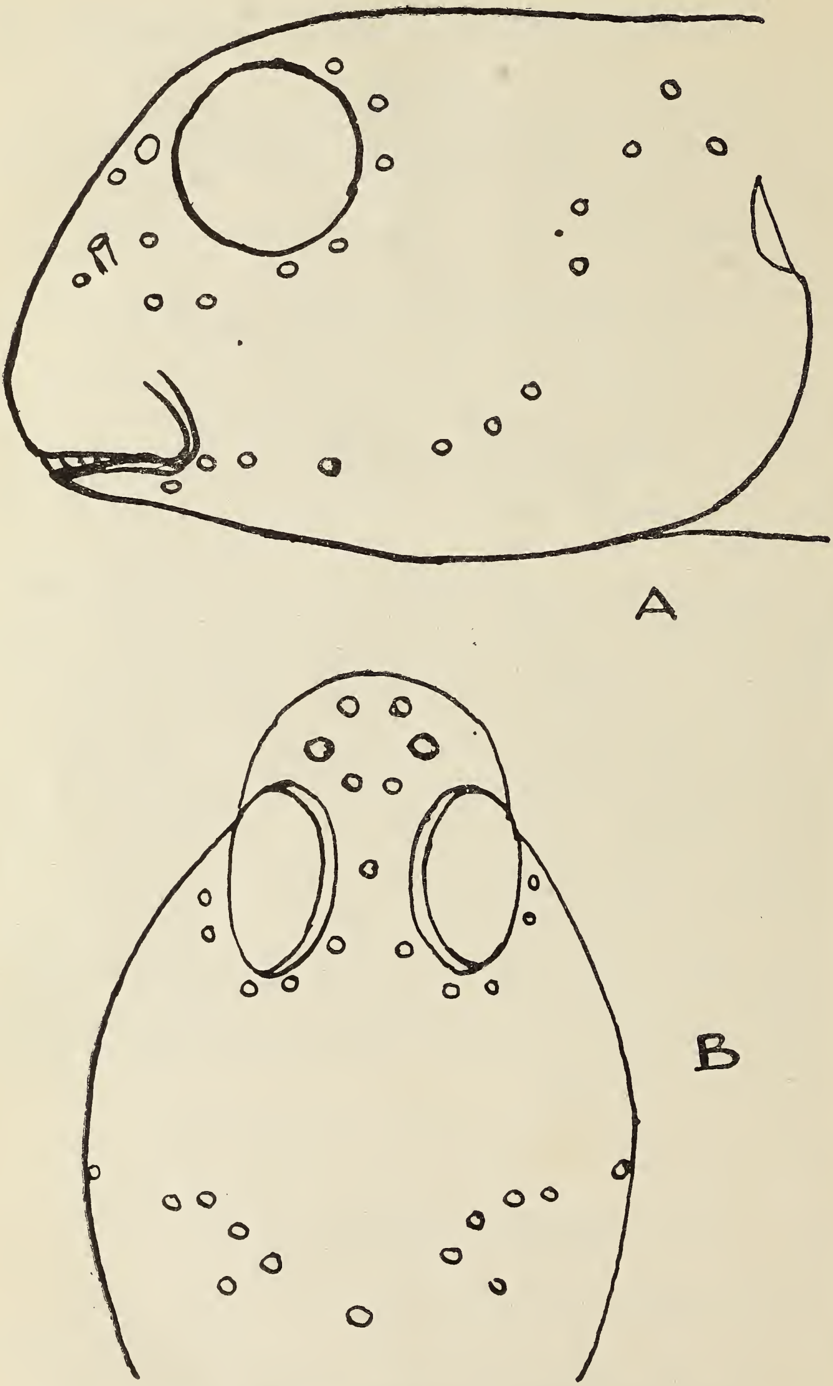

Fig. 1. A. Lateral view, and B. dorsal view of the head of blenniid showing the arrangement of pores on head.

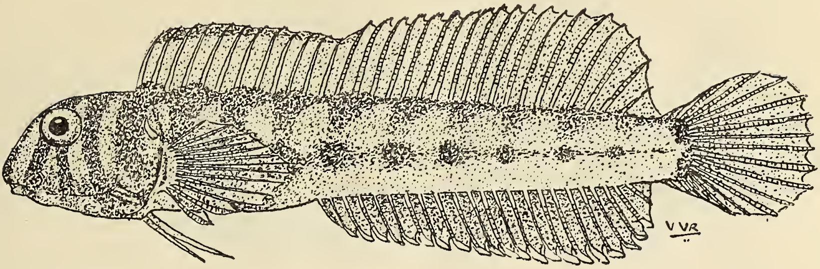

FIG. 2. *Omobranchus bhattacharyae* (Chaud.), male, total length 65 mm.

Omobranchus bipunctatus (Day)

Only two specimens (51 and 65 mm in total length) could be collected during the course of the investigations.

Omobranchus japonicus (Bleeker)

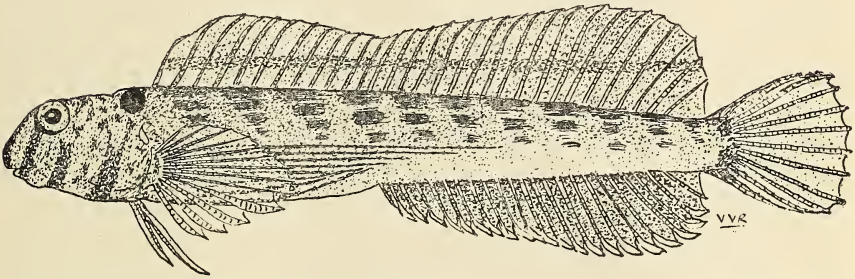

FIG. 3. *Omobranchus japonicus* (Bleeker), male, total length 67 mm.

This species (34 to 70 mm in total length) occurs in considerable numbers in the estuary but is restricted to creeks nearer to sea.

Cruantus smithi sp. nov.

Holotype : Male, 65 mm standard length.

Paratypes : Two males, 46·5 mm and 52 mm and two females 49 mm and 40 mm standard lengths. Specimens deposited in the Zoology Museum, Andhra University, Visakhapatnam.

Description : Based on many specimens ranging from 27 mm to 75 mm total length.

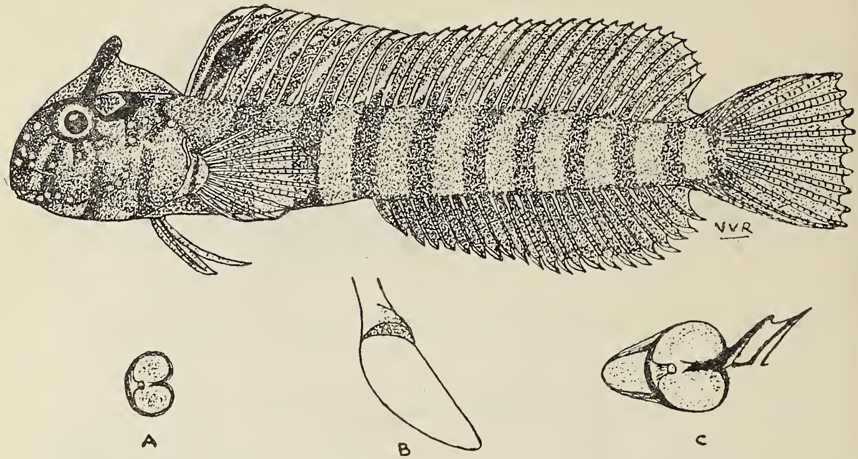

FIG. 4. *Cruantus smithi* sp. nov. type, male, total length 75 mm and enlarged views of A. anal papilla of male, B. tip of anal ray of male showing the spade-like expansion mounted on a fleshy base and C. anal papilla of female showing the nature of attachment of the first anal ray.

D 31-32 ; A 23-24 ; V 1+2 ; P 13 ; C 13 ; GR 2·6 ; Vert. 10-11 + 26-28.

Head bulky, body elongated gradually narrowing to caudal base. Depth 5·2-6·0, head 3·5-4·5 in standard length. Eye 3·0-4·0 in head, snout slightly rounded, a little less than eye. Males with a semicircular crest on head from before eye to dorsal origin with a tentacle in it above eye which is more than orbit. Downward flaps on both lips at the corners of mouth. Each jaw with 18 teeth, lower canines one and half the upper. Pores on snout, around orbit and from gill opening to lower jaw across preopercular margin. Lateral line as a faint groove, bends below 9th dorsal spine, continues to caudal base along mid side. Anal papilla well developed in females.

Dorsal origin above gill openings, margin slightly concave in the middle, otherwise spines and rays of same height which is equal to depth. Anal origin below 11th dorsal spine, more or less equi-distant from snout tip and caudal base, first two rays short, rest gradually increase in length posteriorly, height two-thirds in depth. Ventral a little less than two-thirds in head, split at half the length, outer ray one-fourth smaller than the inner. Pectoral less than three-fourths in head. Tips of anal rays spade-like in males. Membrane from the last ray of dorsal and anal joined to caudal base. Head and body pink to violet in males and pinkish yellow in females and juveniles, head and anterior third of body being darker. Males when agitated or kept against a dark background attain deep violet colour. Light blue spots on head corresponding to pores. Snout dark, a horse-shoe-shaped black ring of about the size of orbit behind eye on either side. Three dark violet bands radiate from the lower margin of orbit, the 1st passes down the corner of mouth to lower jaw, 2nd and 3rd extend only to upper third of preopercle. Two bands one from preopercle and the other from opercle to ventral side of head, both meet bands from opposite side below, a short band from below posterior part of the horse-shoe-shaped ring behind which is somewhat curved band extending from above the band on opercle to dorsal origin. Crest on head light violet, tentacle dark violet to black. Sides with 9-10 dark violet bands, slightly narrower than the ground colour, these bands are lighter in females and juveniles. Dorsal and anal violet, the latter much darker, the former with a dark violet blotch obliquely across 2nd and 3rd spines and about 12-13 irregular white streaks on the entire fin, entire free margin of dorsal bright yellow. Pectoral, ventral and caudal pale yellow, a dark band on pectoral base. Tips of anal rays pale.

A comparative account of the new species and the other two known species of *Cruantus*, *C. dealmeida* and *C. petersi* (Kossman & Rauber) (Smith 1959) is given below.

	C. smithi	*C. dealmeida*	*C. petersi*
St. length Depth	5·2-6·0	5·1-5·5	5·7
St. length Head lth.	3·5-4·5	4·2-4·5	4·5
Head lth. Eye	3·0-4·0	2·8-3·5	4·0
Gill opening :	To upper part of pectoral base	To upper part of pectoral base	Over almost whole pectoral base
Teeth in each jaw	18	18	30
Pelvic fins :	Shorter than head	Equal to head	Shorter than head
	Dorsal and anal joined to caudal base	Dorsal and anal joined to caudal base	Dorsal and anal joined to caudal peduncle

Apart from the abovementioned differences *C. petersi* also differs from the other two species in the colour pattern which is according to Smith (1959) : 'Blue white, scattered deep blue spots. Black stripe along back from snout, tapers to caudal. On 13-17th anal rays an oval white spot, other fins colourless.' The presence of crest with a tentacle on head in males and the characteristic coloration distinguishes the new species.

The new species is named after late Prof. J. L. B. Smith who has contributed much to our knowledge on the blenniid fishes.

This species is very widely distributed among the creeks of Godavari estuary and occurs in moderate numbers even in the middle reaches of the estuary.

Cruantus dealmeida (Smith)

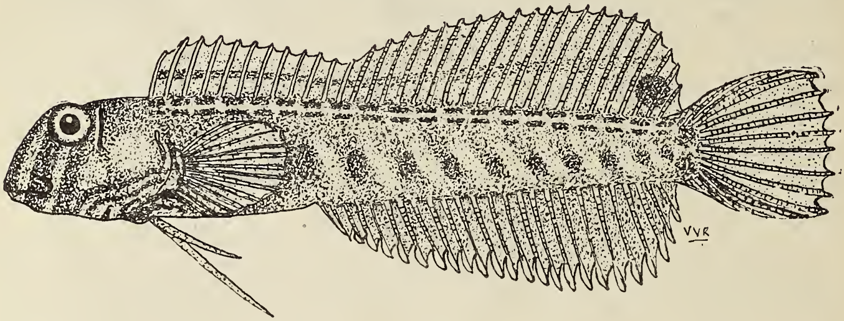

Fig. 5. *Cruantus dealmeida* (Smith), male, total length 54 mm.

Many specimens ranging from 20 mm to 60 mm total length.

Outside India it has been recorded only from Ponte Maeone, Delagoa Bay, South Africa (Smith 1959). The Godavari specimens slightly differ from the South African specimens in the nature of coloration. The black spot at the end of dorsal fin is restricted only to males. Smith (1959) has not mentioned any such sexual specificity of this character, probably because his description is based only on two specimens.

The species is the most widely distributed, occurring in good numbers in the lower reaches as well as in the middle reaches of the estuary.

Habitat: As stated earlier, Godavari estuarine blenniids inhabit mangrove stems and roots exclusively and are not found elsewhere. They occupy the stems and roots at the level of high water mark in relatively higher numbers than those at the low water mark. The stems and roots at the entrance of creeks are occupied in greater numbers than those in the interior. In a few instances they also inhabited dead and decaying stems jutting out 15 to 30 mm above the mud. In each case, juveniles always occupied the upper part of the stem and adults were found deeper down. Each long bore with several interconnected small bores is occupied by many fish, always belonging to the same species, thus, showing species segregation. Few experiments carried out did not indicate any homing instinct among these fish. Whenever they were removed from the bores and placed on mud they used to crawl back to the nearest stem or root and enter the bore. In no case were they observed to make any attempt to return to the original stem or root they inhabited.

The fish are more abundant in creeks nearer to sea, and their frequency gradually decreases up river. However, they were also seen on mangrove stems of creeks where the salinity varies from about 2 ‰ to 33·5 ‰ during different seasons. In one creek which is about 15 km away from the sea (the maximum distance at which these fishes were collected) where the salinity drops down to zero now and then due to fresh water drainage from the adjacent irrigation fields, these blenniids, especially *C. smithi*, were not only found to be unaffected by this fluctuation in salinity, but also bred in the bores. This clearly shows that these fishes are capable of tolerating wide fluctuations in hydrological conditions and, the decrease in their numbers from sea up the river is perhaps to be attributed to the sparse distribution of mangrove plants in the middle and upper reaches of the estuary.

It is difficult to say what happens to these fishes during the flood season (July to August) when the sea water in the entire estuary is replaced by flood waters. As stated above, these fishes generally occupy the roots and stems at the level of high water mark which are not likely to be submerged for a prolonged period by the flood waters ; it is likely, therefore, that they remain unaffected by the rise in water level or might crawl further up inside the bores. The fact that the stems and roots examined soon after the flood period, when it was possible to reach the creeks, were occupied by these fishes suggests that they do not leave the bores even during flood period.

ACKNOWLEDGEMENTS

I am thankful to Prof. S. Dutt for kindly going through the manuscript and offering valuable suggestions. My thanks are due to Mr. P. J. P. Whitehead for useful criticism. I am grateful to Prof. P. N. Ganapati for facilities. To the Indian Council of Agricultural Research I am indebted for the Research Assistantship, during the tenure of which this work has been carried out.

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Trapping of small mammals in relation to the vegetation types in the Kyasanur forest disease area, Mysore State, India[1]

BY

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During the course of investigation of Kyasanur Forest Disease (KFD), several isolations of KFD virus were obtained from the organs of wild caught small mammals and their tick ectoparasites (Boshell *et al.* 1968 a & b; Rajagopalan *et al.* 1969). Since this indicated a possible involvement of small mammals in the natural cycle of KFD, attempts were made to study the relationship between small mammals and vegetation types, with a view to understand the interrelationship between vectors, hosts and habitats in the Kyasanur Forest Disease area.

MATERIALS AND METHODS

Four different areas each having one or more habitat types were selected for trapping the small mammals. These areas were located near the villages of Kuruvari, Balagodu, Kalkoppa and Kangodu. The different habitat types selected for trapping are shown in Table 1. In areas around Kuruvari and Balagodu, the trapping was done from May 1969 to April 1970; in areas around Kalkoppa, from August 1969 to April 1970, and in areas around Kangodu, from Sept. 1969 to April 1970. Eighty to one hundred sherman traps were set in marked places 30 to 40 ft. apart with 'pakoda' as a bait. The traps were left overnight and collected on the following morning. The trapped small mammals were released after identification.

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DESCRIPTION OF AREAS

Kuruvari :

This trapping area consists of semi-evergreen forest, scrub forest, edge of the forest and paddy field. The semi-evergreen forest is composed of tall trees and thick undergrowth, providing a good uninterrupted ground cover. The top soil consists of dead and decaying leaves and other forest litter. Scrub forest encircles the semi-evergreen forest on three sides. Here the ground cover is sparse and consists mainly of wild date palm (*Phoenix* sp.) and a few short trees. This leaves considerable areas of the ground exposed and open. The paddy field is situated in the shallow valley and has a terraced appearance. The edge of the forest which runs along the paddy field is an abrupt end of the semi-evergreen forest.

Balagodu :

This study area includes the edge of a semi-evergreen forest with large thickets of lantana (*Lantana aculeata*), and a paddy field.

Kalkoppa :

Here the trapping was done in a teak plantation (*Tectona grandis*), which has a thick undergrowth composed mainly of lantana bushes.

Kangodu :

Peridomestic areas was selected in a narrow patch of cleared zone adjacent to Kangodu village.

RESULTS

In all 493 small mammals belonging to 8 species were trapped in 6810 trap nights. The composition of the species of small mammals, in the order of numerical abundance were : *Rattus rattus wroughtoni* (39·1%), *Suncus murinus* (35.9%), *Rattus blanfordi* (14·4%), *Mus* sp. (6·1%), *Rattus rufescens* (3.0%), *Funambulus tristriatus tristriatus* (1·0%), *Golunda ellioti* (0.2%) and *Tatera indica* (0·2%). Of the 8 species of small mammals trapped the relationship between the habitat types and the distribution could be assessed only for three species, viz., *Rattus r. wroughtoni*, *S. murinus* and *R. blanfordi*. The other species of small mammals were trapped in small numbers, and it was not possible to associate them with any habitat types.

Table 1 gives the distribution of small mammals according to the habitat types. The total number of small mammals trapped at the edge of the forest exceeded the number trapped from other habitat types. *Rattus r. wroughtoni* was trapped most frequently from semi-evergreen

TABLE 1

NUMBER AND SPECIES OF SMALL MAMMALS TRAPPED FROM FOUR LOCALITIES ACCORDING TO HABITAT TYPES (NUMBERS IN THE PARENTHESIS GIVE THE PERCENTAGES)

Locality	Habitat types	No. of trap nights	*R.r.w.*	*R.b.*	*S.m.*	*M.*sp.	*F.t.t.*	*R.r.*	*G.e.*	*T.i*	Total
KURUVARI	(1) Semi-evergreen forest	835	69 (84·1)	8 (9·7)	3 (3·6)	2 (2·4)	0	0	0	0	82
	(2) Scrub forest	779	12 (41·4)	5 (17·2)	4 (13·8)	8 (27·6)	0	0	0	0	29
	(3) Edge of semi-evergreen forest with scrub forest	286	9 (52·9)	4 (23·5)	0	4 (23·5)	0	0	0	0	17
	(4) Edge of semi-evergreen forest with paddy fields	700	9 (27·2)	4 (12·1)	15 (45·4)	3 (9·1)	0	0	1 (3·0)	1 (3·0)	33
	(5) Paddy fields	700	2 (4·1)	0	46 (93·9)	1 (2·0)	0	0	0	0	49
BALAGODU	(1) Edge of semi-evergreen forest with paddy fields	920	63 (51·6)	34 (27·9)	13 (10·7)	1 (0·1)	4 (3·3)	7 (5·7)	0	0	122
	(2) Paddy fields	920	2 (3·8)	0	41 (77·3)	6 (11·3)	0	4 (7·5)	0	0	53
KALKOPPA	Teak plantation	960	19 (51·3)	10 (27·0)	4 (10·8)	4 (10·8)	0	0	0	0	37
KANGODU	Peridomestic area	710	8 (11·3)	6 (8·4)	51 (71·8)	1 (1·4)	1 (1·4)	4 (5·6)	0	0	71
	Total :	6810	193 (39·1)	71 (14·4)	177 (35·9)	30 (6·1)	5 (1·0)	15 (3·0)	1 (0·2)	1 (0·2)	493

R.r.w. = *Rattus rattus wroughtoni*
R.b. = *Rattus blanfordi*
S.m. = *Suncus murinus*
*M.*sp. = *Mus booduga* or *Mus cervicolor*

F.t.t. = *Funambulus tristriatus tristriatus*
R.r. = *Rattus rufescens*
G.e. = *Golunda ellioti*
T.i. = *Tatera indica*

forest (84·1% of small mammals trapped in this habitat type) and a lesser extent from the edge of the semi-evergreen forest (52·9%), teak plantation (51·3%) and scrub forest (41·4%). *S. murinus* formed 71·8% and 93·9% of small mammals trapped from peridomestic area and paddy fields respectively. Except for the edge of the forest along the paddy field at Kuruvari, in the other habitat types the trapping of *S. murinus* was considerably low. *R. blanfordi* was trapped more frequently in the lantana thickets of forest edge (27·9%) and teak plantation (27·0%) than in other habitat types.

DISCUSSION

The trapping results of the present observations indicate a certain degree of preference in at least 3 species of small mammals to a particular habitat type. Though *Rattus r. wroughtoni* were trapped most frequently from the semi-evergreen forest at Kuruvari, to a lesser extent they were also trapped in the scrub forest and teak plantation. This species is known to inhabit the tree holes (Rajagopalan 1970). Therefore, the presence of large number of *Rattus r. wroughtoni* in semi-evergreen forest may have some bearing with the availability of tree holes in this habitat type. The trapping of large number of *S. murinus* from the paddy fields and peridomestic area, is an observation of considerable interest. Because, this habitat does not seem to favour other species of small mammals. The paddy fields also remain flooded during the monsoon months between June to September. The trapping of *S. murinus* in the paddy fields during monsoon months indicates that flooding does not affect their distribution. The only other habitat where *S. murinus* was trapped in considerable number was the edge of the semi-evergreen forest adjacent to the paddy fields at Kuruvari. Another observation of some interest is the trapping of more *R. blanfordi* from the lantana-covered edge of the forest and teak plantation. This gives a slight indication of their preference to the thickets.

Constant exploitations by man over several years have brought about marked ecological changes in the Kyasanur Forest Disease area. While analyzing the results of this nature one should ponder over the possibility of several factors responsible for the distribution of small mammals, such as: availability of food, shelter, presence or absence of predators etc. However, not much information is available on this aspect for most of the species. Perhaps a more intensive study giving consideration to the several parameters, may reveal the complex nature of inter-relationship between the small mammals and their habitats.

SUMMARY

Four hundred and ninety-three small mammals belonging to 8 species were trapped at different habitat types in the Kyasanur Forest Disease area. The habitat types selected for the study were : semi-evergreen forest, scrub forest, edge of the forest, paddy fields, teak plantation and peridomestic area. While 84·1% of small mammals trapped in the semi-evergreen forest was *Rattus r. wroughtoni*, *S. murinus* formed 71·8% and 93·9% of small mammals trapped at peridomestic area and paddy fields respectively. *R. blanfordi* were trapped more frequently in the lantana thickets along the edge of the forest and teak plantation, where it formed 27·9% and 27·0% respectively of the small mammals trapped in these regions.

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New Plant records for the Upper Gangetic Plain[1]

BY

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(*With two plates*)

Five species are reported in this paper as new records for the Upper Gangetic Plain. These are: *Erigeron karvinskianus* DC., *Eupatorium riparium* Regel, *Hibiscus furcatus* Roxb., *Indigofera arrecta* Hochst. and *Justicia prostrata* (Clarke) Gamble. Apart from being a new record for the above-mentioned area, *H. furcatus* is also reported here for the first time from the N.W. Himalayas. Illustration for this taxon as well as for *E. riparium* are provided.

During the course of identification of plants in the F.R.I. (Dehra Dūn) Herbarium the following five species were detected by the authors to be new records for the Upper Gangetic Plain. This area of *c*. 480,000 sq km is defined to cover the States of Uttar Pradesh, Delhi, East Rajasthan including the former Ajmer-Merwara and the northern portion of Madhya Pradesh including the former Madhya Bharat, Bhopal and Vindhya Pradesh; places above 700 m of altitude within the area are, however, excluded.

These plants were not included by Duthie (1903-29) in his ' Flora of the Upper Gangetic Plain ', nor have they been reported by subsequent botanists working on the vegetation of this region. The present paper, therefore, records for the first time the occurrence of these taxa in this region.

Apart from being a new record for the Upper Gangetic Plain, *Hibiscus furcatus* Roxb. is also reported here for the first time from N.W. Himalayas. *Eupatorium riparium* Regel, an ornamental plant from the Americas, does not find mention in any of the Indian Floras. Recently, Raizada & Saxena (1967) have listed it as occurring occasionally under ' apparently wild ' condition in the vicinity of Mussoorie. The plant is, however, reported here as occurring under fully naturalised condition in our country. Illustrations for both these plants are provided.

Relevant synonymy, brief description, phenology, general distribution and places of collection (within the area and in some cases in

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adjoining areas also) of each species are given. The descriptions are mainly based on the specimens collected from within the region and quoted in the paper, but they have invariably been compared with the original descriptions of the types and also with the accounts appearing in various earlier publications cited under synonymy. The specimens quoted in the paper, unless otherwise stated, are lodged in Dehra Dun Herbarium. The species are arranged alphabetically.

Erigeron karvinskianus DC.

Prod. 5 : 285 (1836) ; Standley *Trees & Shrubs Mexic.* 2(5) : 1499 (1961).

Syn. *E. mucronatus* DC. *loc. cit.* (1836); Fyson *Hillt. Fl.* 1: 223 (1915) ; Gamble *Fl. Mad.* 2 (4) : 682 (1921) ; Raizada in *Indian For.* 85 (11) : 679 (1959).

E. trilobus Sonder in *Hamb. Gart. Zeit.* 12 : 78 (1856) *excl. syn.*

E. karvinskianus var. *mucronatus* Hieron. in Engler *Bot. Jahrb.* 28 : 585 (1900).

Vittadinia triloba auct. non DC. *nom. al.* Fyson *loc. cit.* (1915) ; Standley *loc. cit.* (1961).

V. australis auct. non. A. Rich. *nom. al.* Fyson *loc. cit.* (1915) ; Gamble *loc. cit.* (1921).

A slender, decumbent herb, 60 cm long or less. *Leaves* alternate, lanceolate, entire or lobed, lobes mucronate, base attenuate, glabrous or minutely ciliate. *Heads* long-peduncled and solitary, terminal or axillary ; *ray-florets* white or pinkish ; *disc-florets* yellowish. *Ligules* biseriate. *Pappus* double.

Flowering and *fruiting :* Throughout the year.

Indigenous to Mexico and Central & South Americas where it was erroneously called *Vittadinia triloba* DC., earlier. Cultivated and run wild in Nilgiris, Mussoorie and Dehra Dun. Common along water channels.

In Nilgiris it has for long been known under the wrong name of *Vittadinia australis* A. Rich. which is an Australian species and is altogether different (*cf.* Fyson *loc. cit.* 1915 & Gamble *loc. cit.* 1921).

Dehra Dun : Ballupur (Dec. 1965) *R. Dayal* 460 ; New Forest (Apr. 1969) *H. B. Naithani* 6555 ; Tons Nullah (Apr. 1969) *H. B. Naithani* 6556 ! ; Bijapur Canal (June 1969) *H. B. Naithani* 6940.

Eupatorium riparium Regel

Gartenfl. 324 (1866); Standley *Trees & Shrubs Mexic.* 2 (5): 1464 (1961); Raizada & Saxena in *J. Bombay nat. Hist. Soc.* 64 (1): 83 (1967). (Plate I).

Syn. *E. flexicaule* Schnittspahn *Zeitschr. Gartenb. ver. Darmstadt* 6: *Anlage* 2 : 5 (1857) *nom. nud.*

E. riparium Schultz in Schnittspahn *loc. cit.* (1857) *nom. nud.*

E. harrisii Urban *Symb. Antill.* 1 : 460 (1900).

A slender, herbaceous plant with terete, flexous, finely pubescent, at length somewhat lignescent stems. *Leaves* opposite, lanceolate, attenuate to each end, serrate from near the middle outward, 3-nerved from the base, 5-10 × 1-2·5 cm, sparingly pubescent on the nerves. *Corymbs* numerous, small, panicled; *phyllaries* pale-green, lanceolate, scarious-edged; *corollas* white.

Flowering: January-March. *Fruiting:* April-June.

Indigenous to Mexico and West Indies. Flowers copiously. In Mexico it has long been valued for hot-house cultivation. Cultivated in gardens in northern India. Run wild in Mussoorie and Dehra Dun.

Dehra Dun: Bamboo Plantation, F.R.I. (March 1965) *R. Dayal* 4 !; near M.F.P. Nursery, F.R.I. (January 1967) *H. B. Naithani* 1928; Teak Gate Road, New Forest (May 1967) *R. Dayal* 21759; Tons Nullah (Feb. 1969) *R. Dayal* 21800.

Mussoorie: Bhatta Falls, 1494 m (March and April 1961) *H.O. Saxena* 1668 and 1820 (b).

This plant is not mentioned in any of the Indian Floras. Raizada and Saxena (1967) have, however, mentioned it as occurring occasionally near Bhatta Falls in Mussoorie. But, most probably, not being sure of its naturalised condition, on account of the collection being only from one small locality, they have preferred to call it ' apparently wild '. Now, since this species has also been collected from at least 3 different localities in Dehra Dun, it can safely be said to have escaped from cultivation and thus become completely naturalised in our country. It has already established itself in Dehra Dun, and it would be interesting to watch its further spread, particularly in the plains districts.

Hibiscus furcatus Roxb.

Hort. Beng. 51 (1814); DC. *Prod.* 1 : 449 (1824); Spr. *Syst.* 3 : 102 (1826); Roxb. *Fl. Ind.* 3 : 204 (1832); W. & A. *Prod.* 1 : 48 (1834);

Dalz. & Gibs. *Bomb. Fl.* 19 (1861) ; Mast. in Hook. *f. Fl. Brit. Ind.* 1 : 335 (1874) ; Prain *Beng. Pl.* 1 : 267 (1903) ; Talbot *For. Fl.* 1 : 119 (1909) ; Gamble *Fl. Mad.* 1 (1) : 97 (1915) ; Haines *Bot. Bihar & Orissa* 2 : 67 (1921) ; van Waalkes in *Blumea* 14 (1) : 59, 84 (1966). (Plate II).

Syn. *H. rostellatus* Guill. *et* Perr. *Fl. Seneg.* 1 : 55 (1830) ; Mast. in Oliv. *Fl. Trop. Afr.* 1 : 201 (1868) ; Keay in *Fl. W. Trop. Afr.* 2nd ed. 11 (2) : 346 (1958).

H. aculeatus Roxb. *Fl. Ind.* 3 : 206 (1832).

H. hispidissimus Griff. *Notul.* 4 : 52 (1851).

H. furcellatoides Hochr. in *Ann. Conserv. & Jard. Bot. Geneve* 20 : 157 (1917).

An erect (or rambling ?), suffruticose, slender, shrub up to 4 m high with pungent, recurved prickles. *Leaves* 5 cm across, entire or slightly lobed, cordate, pubescent, crenate ; *stipules* up to 0·5 cm long, linear-lanceolate. *Flowers* large (5 cm in diam.), axillary, sub-racemose, distant with 10-12 setose forked bracteoles ; *calyx* enlarged in fruit, very hispid and with shining bristles ; *corolla* yellow with a crimson centre.

Capsule 1 cm long, enclosed in the enlarged calyx.

Flowering : September, October. *Fruiting :* November, December.

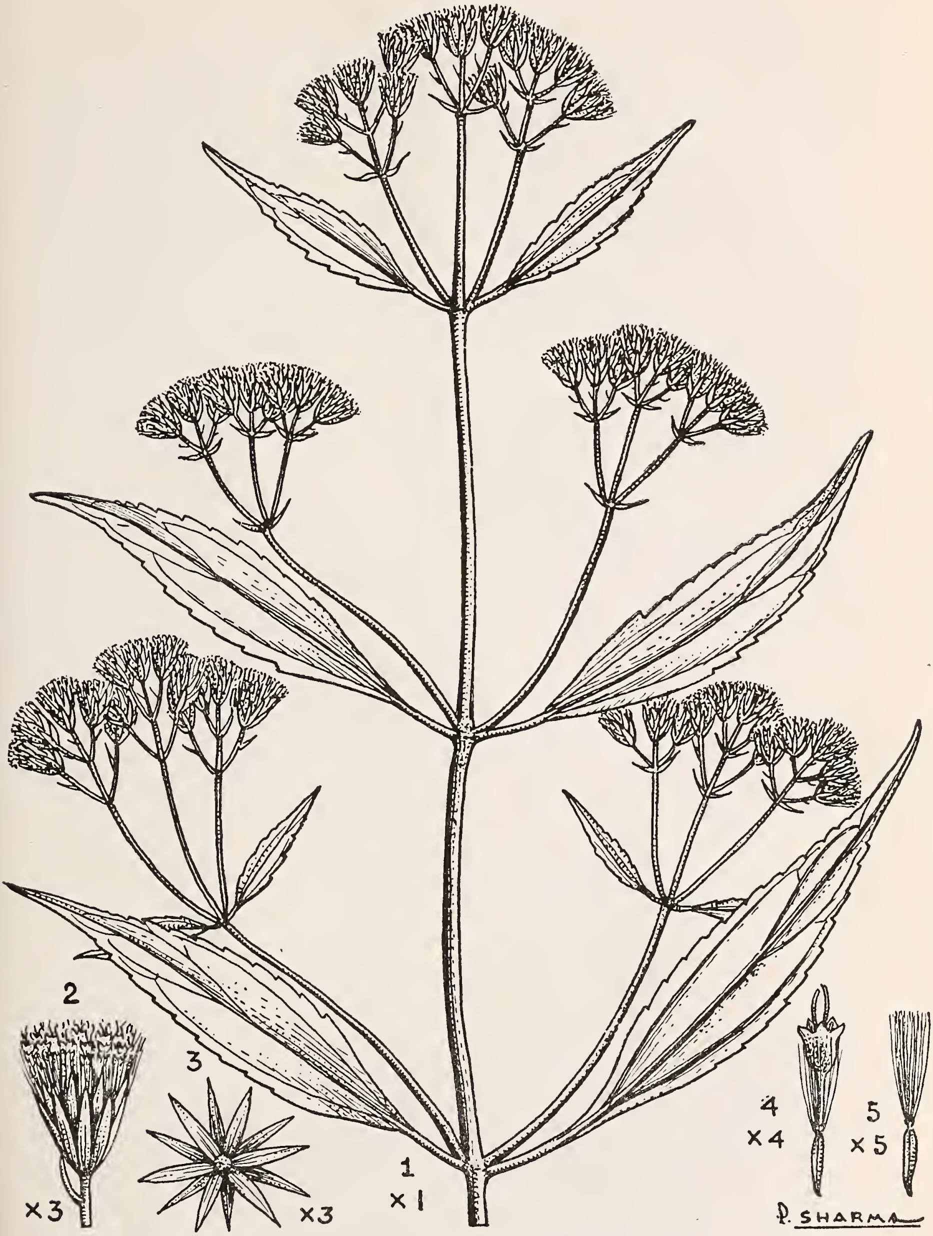
Tropics of the old world. Common in hotter parts of India, ascending to 1220 m in N. W. Himalayas. (This species was so far known to occur in the plains of peninsular India, Bengal and Orissa.)

Dehra Dun : Saura Village, Raipur (Sept. 1968) *D. P. Raturi* 6251 ; Song River, Raipur (Sept. 1968) *D. P. Raturi* 6252 ; Pump-House, near Ordnance Factory (Sept. 1968) *D. P. Raturi* 6253.

Tehri-Garhwal : Tehri, 1219 m (Sept. 1875) *anonymous s.n.*

Apart from being a new record for the Upper Gangetic Plain, this species is reported here for the first time from the N.W. Himalayas, namely Tehri-Garhwal.

It is interesting to note that the specimens of this species collected from North India have a very short peduncle (5-7 mm), a character which compares favourably with Roxburgh's description of the type. The specimens from South India available in Dehra Dun Herbarium, however, show a very long peduncle (4-5 cm) and agree with the description of Talbot (1909) and others. This variation has to be looked into, and for this, further material from South India needs to be examined.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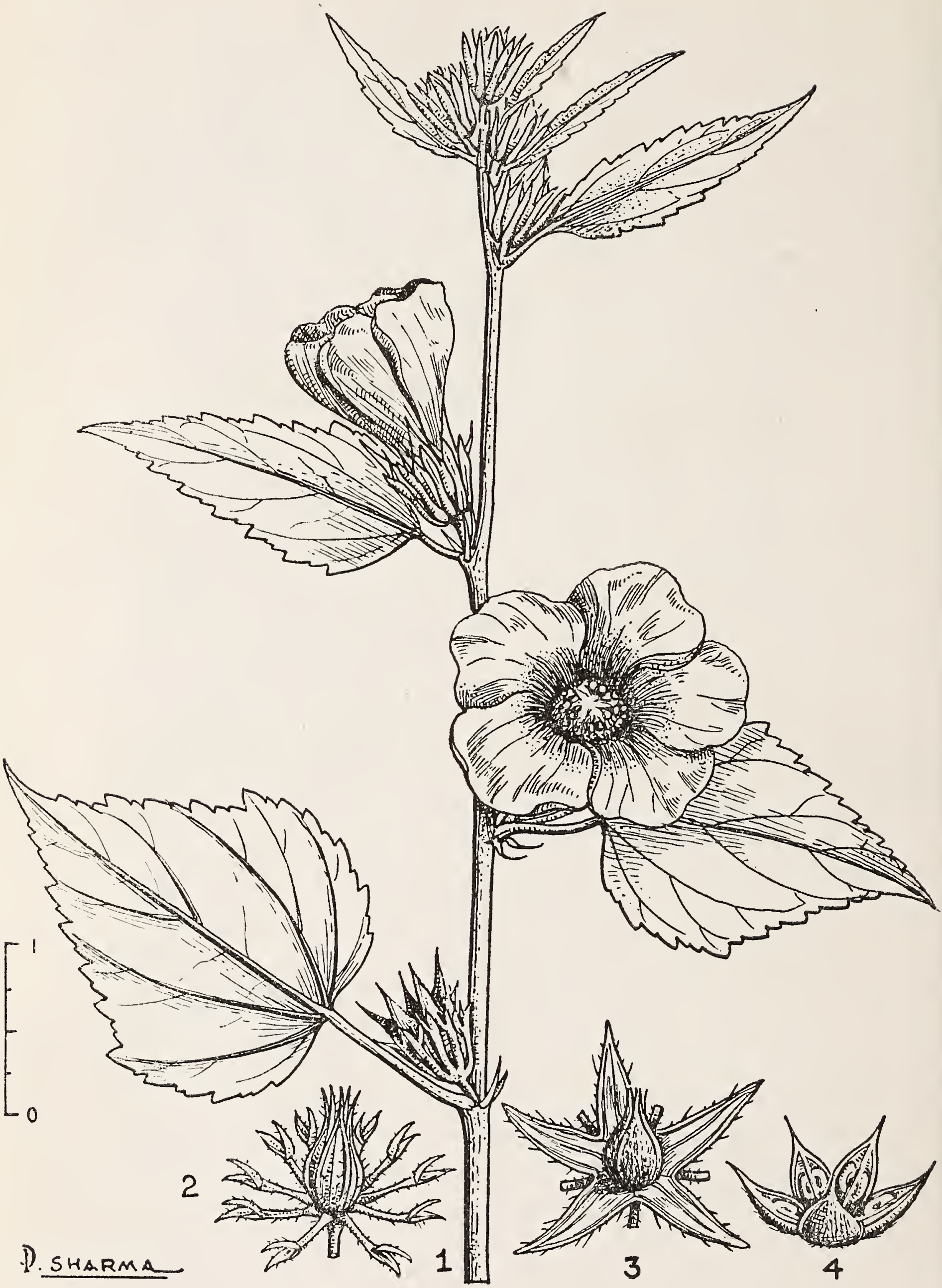
P. SHARMA

Eupatorium riparium Regel

1. a portion of the plant; 2. inflorescense; 3. phyllaries; 4. a single flower;
5. seed with pappus.



Hibiscus furcatus Roxb.

1. a portion of the plant; 2. stipules and bractioles; 3. capsule with enlarged calyx; 4. opened capsule showing seeds.

There also seems to be a correlation between the size of the peduncle and the lobation of leaves. The leaves in the specimens from North India which have very short peduncles are either entire or only superficially lobed as shown in the illustration (Plate II), while in the South Indian specimens having long peduncles they are invariably deeply lobed and are seldom entire.

H. furcatus Roxb. is very close to *H. surattensis* L., a widely distributed Indian species. It can, however, be distinguished from the latter by the oblong lanceolate stipules and linear forked bracteoles (epicalyx). *H. surattensis* on the other hand, has broad auriculate stipules and spathulate bracteoles which are provided with an appendage.

Indigofera arrecta Hochst. ex A. Rich.

Tent. *Fl. Abyss.* 1 : 184 (1847) ; Baker in Oliv. *Fl. Trop. Afr.* 2 : 97 (1871) ; Haines *Bot. Bihar & Orissa* 2 : 239 (1921) ; Koorders *Exkursiansfl. Java* 4 (7) : 947 (1926) ; Nicholls & Holland *Text Book Trop. Agric.* 38 (1929) ; Nicholes in *Bull. Dept. Agric. Gold Coast* 16, t. 61 (1929) ; Hepper in Keay *Fl. W. Trop. Afr.* 2nd ed. 1 (2) : 541 (1958).

Syn. *I. tinctoria* var. *arrecta* Berhaut in Chev. *Bot.* 50 (1920).

An erect, deep-green, leafy undershrub 1-2 m high, with angled and grooved thinly strigose stems. *Leaves* pinnate, 10-13 cm long with *c.* 7 pairs and 1 odd leaflet. *Flowers* inconspicuous, pink-red, in solitary axillary racemes up to 4 cm long, gradually elongating and becoming double the size but bearing pods only near the base. *Pods* straight and reflexed, *c.* 2·5 cm long.

Flowering and *fruiting :* September-February.

Indigenous to tropical Africa and Java. Cultivated in indigo plantations in northern India. Run wild in Dehra Dun.

Dehra Dun : 'Chir' plantation area F.R.I. (Dec. 1954) *T. C. Naithani s.n.*, (Sept. 1965) *R. Dayal* 419 ; New Forest (Aug. 1966) *R. Dayal* 490.

Justicia prostrata (Clarke) Gamble

Fl. Mad. 2 (6) : 1081 (1924) ; Santapau in *Bot. Mem. Un. Bombay* 2 : 88 (1951) *n.v.* ; Ramamurthy in *Bull. Bot. Surv. India* 5 (3 & 4) : 264 (1963) ; Subramanian in *Indian For.* 92 (3) : 46 (1966).

Syn. *J. diffusa* Willd. var. *prostrata* Clarke in Hook. *f. Fl. Brit. Ind.* 4 : 538 (1885) ; Trim. *Fl. Ceyl.* 3 : 338 (1893) ; Cooke *Fl. Bomb.* 2 : 410 (1908).

A small, pale, prostrate herb with diffusely spreading branches. *Leaves* small, opposite, ovate or sub-orbicular, hairy on both surfaces, slightly acuminate or with blunt apex. *Spikes* 7-8 cm long. *Flowers* small, mauve or white. *Bracteoles & sepals* broad and hairy. *Corolla* 4 mm long, pubescent. *Stamens* 2, hairy at the base. *Ovary* glabrous or nearly so ; *styles* long, cylindric, hairy at the base ; *stigma* obliquely capitate. *Capsules* small, puberulous ; *seeds* minutely tuberculate.

Flowering and *fruiting :* Throughout the year.

Peninsular India extending southwards to Ceylon and northwards to the plains of North India. (In India this plant was so far known from southern and western regions only.)

Uttar Pradesh : Bijnore (March 1958) *Y. K. Sarin* 5133 ; Mirzapur Town (Feb. 1961) *U. C. Bhattacharya* 12849 ; Mirazpur District (Feb. 1961) *U. C. Bhattacharya* 13275 ; Ghajipur, Manipur (Feb. 1961) *U. C. Bhattacharya* 13759 ; Lacchiwala, Dehra Dun (March 1961) *M. A. Rau* 13995 ! ; Mirzapur (Sept. 1961) *U. C. Bhattacharya* 17509 ; Mahoba, Hamirpur (Sept. 1961) *U. C. Bhattacharya* 17795 ; Sahawar Town, Distt. Etah (Apr. 1966) *R. Dayal* 5 a-d. (All these specimens excepting the last which is deposited in Herbarium DD, are available in Herb., BSD, Dehra Dun).

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Preliminary notes on the Ornithology of Sandur, Karnataka[1]

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(*With a map*)

This paper introduces the avifauna of Sandur taluk (Karnataka State, India) which includes the former princely state of Sandur, demarcated by two main ranges of high forest-covered hills, joining at both ends to enclose a spindle-shaped valley and presenting a geographical feature quite distinct from the adjacent dry Bellary plain more typical of the Deccan plateau. Notes relating chiefly to the status and distribution of 166 species of birds so far recorded from the area are presented together with 16 further species from other parts of Bellary district. The Sirkeer Cuckoo *Taccocua leschenaultii* and Spotted Babbler *Pellorneum ruficeps* are recorded from Karnataka state and the Deccan plateau respectively for the first time. Occurrence of the Indian Lorikeet *Loriculus vernalis*, Great Grey Shrike *Lanius excubitor*, Whiteheaded Babbler *Turdoides affinis*, Whitebrowed Blue Flycatcher *Muscicapa superciliaris* and Greyheaded Flycatcher *Culicicapa ceylonensis* in the tract are other findings of interest. A brief discussion on the composition of Sandur's bird life is included.

INTRODUCTION[3]

The former princely state of Sandur (14° 58′ to 15° 14′N. and 76° 25′ to 76°42′E.), now a taluk of Bellary district (Karnataka State, India) consists of two main ranges of high forest-covered hills running NW. to SE. and enclosing an elongate spindle-shaped valley, these together presenting a geographical feature quite different from the surrounding dry Bellary region more typical of the Deccan plateau. The present taluk was formed by the addition, to the former state, of parts of the adjacent plains on both sides of the two hill ranges. Sandur state had an area of approximately 375 sq. km and the present taluk is roughly three times this area.

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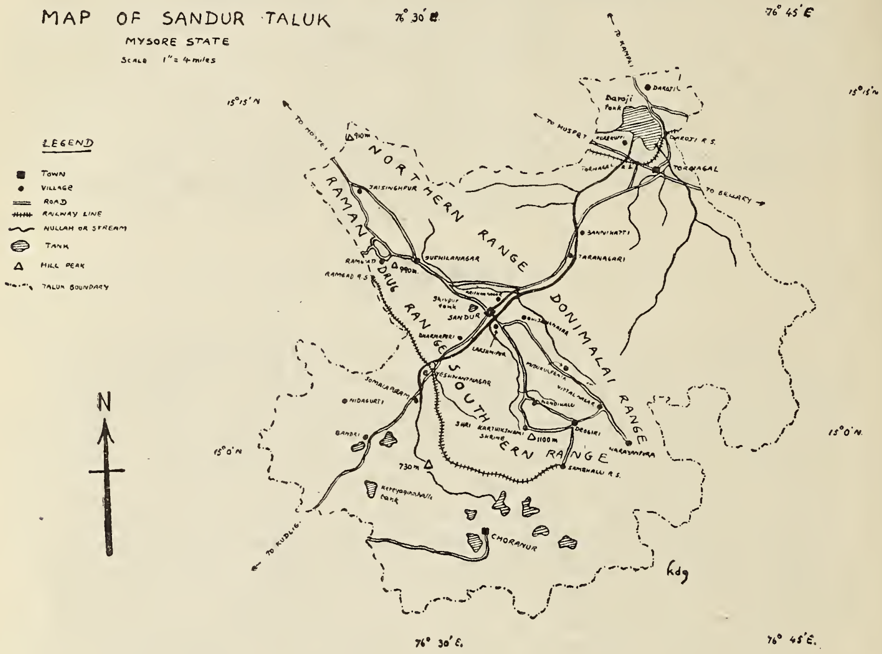
[3] The details of physiography, vegetation and climate are from Krishnan (1948).

Geologically, the Sandur hills belong to the oldest formations of the earth's crust and are flat-topped with a mean elevation of 900 m above m.s.l., the highest point (1100 m) being above Kumaraswamibetta on the Southern range. The soil is deep red and consists of rock, disintegrated trap and sandy gravel with outcrops of lime ' kankar ' here and there Sandur is well known for its manganese ore which together with iron ore occurs in immense quantities in the hills and is being extensively mined. Jasper, ochres, red oxide, white clay and limestone are also found in plenty and old derelict gold mines exist on the Donimalai range. The valley is dotted with smaller hillocks and trenched with numerous nullahs most of which flow into the Narihalla, a large stream, which cuts through both ranges almost bisecting them in two. The gorges so formed serve as the only accessible entries into the Sandur valley.


MAP OF SANDUR TALUK
MYSORE STATE
Scale 1" = 4 miles
LEGEND
TOWN
VILLAGE
ROAD
RAILWAY LINE
NULLAH OR STREAM
TANK
HILL PEAK
TALUK BOUNDARY
N
76° 30' E
76° 45' E
15° 15' N
15° 0' N
To Hospet
To Hampi
To Huspet
To Bellary
To Kudligi
NORTHERN RANGE
RAMANDRUG RANGE
DONIMALAI RANGE
SOUTHERN RANGE
910 m
990 m
1100 m
730 m
Daroji
Daroji tank
Daroji R.S.
Tornagal
Tornagal R.S.
Jaisinghpur
Sushilanagar
Ramgad
Ramgad R.S.
Shivpur tank
Sandur
Krishnanagar
Bannihatti
Taranagari
Dharmapuri
Lakshmipur
Yeshwantnagar
Somalapuram
Nidagurti
Bandri
Muduklpenta
Vittal nagar
Nandihalli
Deogiri
Narayanpura
Shri Karthikswami Shrine
Samehalli R.S.
Kereyaginahalli tank
Choranur
kdg

The Sandur area receives considerably greater rainfall than the surrounding plains, the average annual precipitation varying from 500 mm to 1140 mm in different years with a mean of about 860 mm. The climate is even and pleasant with high winds in July and August and the hot weather limited to a month or two. The local hill resort of Ramgad (990 m) on the Ramandrug range has an equable temperature and a supply of mineral water from the nearby Thayammankolla. The holy shrine of Shri Karthikswami is located on an undulating hill on the

Southern range and beyond this lies the extensive, flat plateau of Deogiri—noted for its heavy jungles and unlimited mineral wealth. The taluk headquarters, Sandur town (Pop. *c.* 9,500) is situated at the centre of the fertile valley on the banks of the Narihalla. Smaller townships and larger villages like Bandri, Choranur, Lakshmipur, Krishnanagar, Nandihalli, Sushilanagar and Yeshwantnagar are scattered all over the taluk (*see* map). The railway town of Tornagal is situated near the Daroji tank at the eastern border of the taluk and a broad gauge line linking it to Mudukulpenta within the valley is under preparation. Sandur town is linked by road to Bellary, 48 km to the east; Kudligi, 28 km to the south-west and Hospet, 34 km to the north-west. The nearest railway station at Tornagal is approachable through Hubli, Gadag and Hospet from the west, and Guntakal and Bellary from the east. There is a Traveller's Bungalow at Sandur town and a newly constructed Forest Rest House is located in a beautiful spot overlooking the Narihalla and encompassed by forested hills.

The forest is restricted to the hill ranges, hillocks and foothills, within the valley and is of the open dry deciduous type, bordering on to moist deciduous on the summits of the highest hills. Although there is natural growth of teak, the trees do not attain anything like their greatest size in Sandur. Local timber is not restricted to Teak (*Tectona grandis*)— *Chloroxylon swietenia*, *Anogeissus latifolia*, *Terminalia tomentosa*, *Pterocarpus marsupium*, *Hardwickia binata*, *Soymida febrifuga*, *Diospyros melanoxylon* and *D. ebenum* also grow well here. Besides these the forest abounds with other species of trees, particularly *Gmelina arborea*, *Azadirachta indica*, *Mangifera indica*, *Adina cordifolia*, *Albizzia amara*, *Acacia catechu*, *A. ferruginea*, *Elaeodendron glaucum*, *Bauhinia racemosa*, *Cassia fistula*, *C. auriculata*, *Pongamia glabra*, *Ailanthus excelsa*, *Semecarpus anacardium*, *Emblica* spp., *Terminalia chebula*, *Sapindus trifoliatus*, *Tamarindus indicus* and several species of *Ficus*. The Sandal tree, *Santalum album* grows sporadically throughout the area but is found mainly in the Ramgad, Swamimalai and Thimappa blocks. The undergrowth on the hills and hillocks consists mainly of short tussocky grass, identified as *Cymbopogon martinii* (Rosa grass), *C. coloratus*, *Heteropogon contortus* and *Sehina nervosum*. Bamboo, chiefly *Bambusa arundinacea* and *Dendrocalamus strictus*, grows in dense clumps particularly on the southern hills. The exotic lantana, introduced into Sandur for ornamental purposes (Ramachandra Rao 1920) has spread considerably all over the hills and in the valley.

The valley is more open and cultivated every bit of fairly level land being converted into fields. Only the hillocks and foothills with forest cover have not been touched but signs of even these being brought under cultivation are evident. The main crops grown here are jowar (the staple food), bajra and groundnut with a fair acreage being put under other grain, pulse, oilseed, fibre and cash crops. Mango orchards abound and the tamarind flanks the roads, paths and streams.

The outer plains on the Bellary side are more open and dry with the hillocks gradually showing a poorer tree growth as one goes away from Sandur until near the edge of the taluk they take up the rocky character typical of the bouldery Bellary hills covered only with a sparse growth of xerophytic vegetation. The only reasonable tree growth here is along the Narihalla which emerges through the Sandur hills and flows eastward towards its ultimate destination—the Daroji tank. On the Kudligi (western) side, the Sandur plains within the taluk limits are more forested, the open jungle on the foothills of the western ranges spreading westward and covering most of the lower hills and hillocks with a shortish, scrub forest. One of these hills, Jarimalaibetta, rises to 730 m above m.s.l. and is the source of the Narihalla. A distinctive feature of this western plain is the number of small lakes and tanks scattered all over the area.

The mammalian fauna of Sandur is rich but steadily decreasing, owing to much poaching and 'shikar'. Leopard, wild boar, sambar, four-horned antelope, the grey langur, jungle cat, the small Indian civet, common mongoose, jackal, the Indian fox, the Indian porcupine, pangolin, the blacknaped hare, several small rodents, bats and other small animals occur, mostly in forest on the hills. The Indian gazelle (Chinkara) and the sloth bear are sometimes seen on the adjacent plains while stray and miserably depleted herds of blackbuck roam the black-cotton soils outside the taluk near Bellary and Hospet. The tiger once wandered into the forested hills but has been completely shot out and only rare unconfirmed reports of tiger crossing into the hills are obtained at present. The monitor lizard, *Varanus bengalensis* and the pond tortoise, *Geomyda trijuga* are common. Other forms of life including snakes, lizards, frogs, freshwater fish, earthworms and other annelids, molluscs, millipedes and other arthropods including scorpions, crabs, spiders and a great variety of insects and mites are abundantly evident here and could offer interesting material for study. The plant wealth of the Sandur hills is certainly undocumented and here is an absorbing field of investigation for the interested botanist, both pure and economic, the latter finding much of value for there is undoubtedly an abundance of medicinal plants, herbs and roots here.

Regarding the bird life of Sandur, Krishnan (1948) writes—'The avifauna of the State is exceptionally rich and provides the student of bird-life with interesting local variations. Several migratory birds seem to linger within the seclusion of these hills longer than at other places.' The only other references to Sandur's ornithology are by Krishnan (1955) on the Rosy Pastor, by Whistler (*in* Ali 1942) on the Yellow-throated Bulbul and by Campbell (1906) on the Whitebellied Drongo;

There is no published account of the Ornithology of Sandur and this paper makes an introductory attempt to supply the deficiency.

There are other reasons which have prompted me to offer these preliminary notes on the avifauna of Sandur. The Deccan plateau as a whole and the northern portion of Karnataka east of the Western Ghats have been largely neglected by ornithologists as substantiated by the following statements :

> ‘There is a huge area in the centre of the Peninsula between the Central Provinces and the southern boundary of Karnataka which is virtually unknown and over which we have found no indication of the distribution of the most common species.’ (Whistler & Kinnear 1932a).

> ‘This bulbul . . . . is apparently much overlooked because of its skulking habits and the fact that the region it inhabits has not received much attention from ornithologists.’ (Whistler *in* Ali 1942).

This being largely true even today, it was thought to be a matter of some urgency to publish my notes, however sketchy, on the birds of this interesting but neglected area if only to put on record the status and distribution of the birds occurring here. In addition, as the Sandur hills constitute a peculiar feature of the Deccan, presenting a habitat very different from neighbouring arid areas, the writing of these notes is further justified. A third point of importance is that the recent acceleration in the development and expansion of the mineral industry in the area, the building of a dam across the Narihalla to enable extensive irrigation facilities to be available to farmers in the taluk, the felling of forests to bring more land under cultivation, the opening up of the tract by modern means of transport and the subsequent increase in population with its resultant side effects, all threaten to change the entire character of this rich area, from a calm and secluded valley to a bustling, industrial complex. It was felt therefore, that an idea of the composition of the avifauna of Sandur that existed here before the terrain was extensively and intensively exploited was essential to appreciate these changes some years hence.

This is an initial attempt to put on record the as yet unaffected bird life of Sandur, as has best been possible through several short trips by the author to the area over the last ten years.

ACCOUNT OF SPECIES

The list that follows is placed in the order of Ripley (1961) and the nomenclature followed is from the same work and the published volumes of the INDIAN HANDBOOK (Ali & Ripley 1968-1972). Subspecies are not discussed (with a few exceptions), although several specimens were collected, as I considered these unimportant as a rule, complicating matters unnecessarily and tending to diminish unjustifiably the real significance of the species category. Species personally seen and identified without doubt and those recorded from Sandur limits by other workers are not bracketed. Birds reported to occur in other taluks of Bellary district are placed in square brackets and are expected to be of some value. The terms *valley, hills* and *plains* should be self-explanatory from the introductory notes.

Podiceps ruficollis (Pallas) : Little Grebe

A rather sparse resident, some individuals staying throughout the year on tanks with water. One or two pairs are invariably found on the tank at Shivpur where they often breed.

Phalacrocorax carbo (Linnaeus) : Large Cormorant

Krishnan[4] has seen this cormorant on the tank at Bandri. A solitary bird was seen by the author on the tank near Chilkanhatti (Hospet taluk, Bellary district) in February 1968. Krishnan noted it on a large tank at Bellary.

Phalacrocorax fuscicollis Stephens : Indian Shag

One unconfirmed record from the tank at Bandri by Krishnan who also reports seeing one at a tank near Bellary town.

Ardeola grayii (Sykes) : Pond Heron

Fairly common resident, locally distributed along the Narihalla and its larger tributaries and around the tanks within and outside the valley. Neginhal (1971) saw these on the water's edge on an island in the Tungabhadra river near Shingtalur (Mundargi taluk, Dharwar district), just across the northern border of Bellary district.

Bubulcus ibis (Linnaeus) : Cattle Egret

Seen only twice attending herds of grazing cattle in the valley in small numbers. It is probably more common in the adjacent plains but my limited work on the bird life of these plains prevents any definite conclusions here. Five normal and two black [melanistic ?] individuals of this species were seen on the Tungabhadra near Shingtalur in February (Neginhal 1971).

Ciconia episcopus (Boddaert) : Whitenecked Stork

Recorded from Daroji tank by Krishnan. Neginhal (1971) reports seeing this stork on the Tungabhadra reservoir. This large stork is quite common in northern Karnataka east of the Western Ghats and some individuals are invariably found frequenting most of the tanks with water.

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[4] References to Krishnan not accompanied by citation of year indicate data communicated by him personally to the author.

Threskiornis melanocephala (Latham) : White Ibis

Krishnan saw these at the Daroji tank and Neginhal (1971) noted them on the Tungabhadra reservoir.

Platalea leucorodia Linnaeus : Spoonbill

I have never seen this bird in Sandur but Krishnan reports seeing it at the Daroji tank.

[The Blacknecked Stork *Xenorhynchus asiaticus* (Latham), Black Ibis *Pseudibis papillosa* (Temminck), Flamingo *Phoenicopterus roseus* Pallas and Ruddy Sheld-duck *Tadorna ferruginea* (Pallas) were recorded from the Tungabhadra reservoir by Neginhal (1971).

One specimen of the Barheaded Goose *Anser indicus* (Latham) was taken at Tungabhadra (Abdulali 1968) and Neginhal (1971) saw them ' resting on sandbanks, in low water, in the middle of the (Tungabhadra) river near an islet.']

Anas acuta Linnaeus : Pintail

Recorded from the tanks at Kereyaginahalli (Sandur taluk, western plain) and Shivpur by A.M.G.[5], but I have no knowledge of it in Sandur. Seen on the Tungabhadra river near the reservoir (Neginhal 1971).

Anas crecca Linnaeus : Teal

Krishnan and A.M.G. report having seen this duck on the tanks at Kereyaginahalli and Shivpur. Noted on the Tungabhadra river near Shingtalur (Neginhal 1971).

Anas poecilorhyncha J. R. Forster : Spotbill

A.M.G. has seen this large duck on the tank at Kereyaginahalli. Noted about ten individuals of this resident duck on the tank near Chilkanhatti in February 1968.

Anas penelope Linnaeus : Wigeon

A couple of these birds were seen and shot on Shivpur tank on December 3, 1971, and were identified as this species. Also reported from Kereyaginahalli tank by A.M.G. in winter.

Anas querquedula Linnaeus : Garganey

A.M.G. records this common wintering duck from Kereyaginahalli tank. Observed on the Tungabhadra river near Shingtalur (Neginhal 1971).

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[5] Ajai M. Ghorpade, a resident birdwatcher of Sandur, has kindly supplemented the author's observations with his own experiences of Sandur's birds.

Anas clypeata Linnaeus : Shoveller

A solitary bird was seen and shot along with the two wigeon on December 3, 1971, at Shivpur tank. A.M.G. has seen it at the tank near Kereyanginahalli in winter.

Aythya ferina (Linnaeus) : Redheaded Pochard

Recorded by A.M.G. from the tanks at Kereyaginahalli and Shivpur in winter. I have no record of this species from Sandur although it must surely be one of the more abundant wintering ducks in the area. I saw about fifteen pochard in February 1968 on the Chilkanhatti tank.

[Baker (1900) quotes Hume who states that the Tufted Duck *Aythya fuligula* (Linnaeus) has been shot near Bellary and that though certainly rare there it visits Mysore. Ali and Ripley (1968) comment in the INDIAN HANDBOOK—' Decreasingly in the Deccan and farther south to Mysore (rare).' In November 1971 a female of this species was secured from a tank in Yelburga taluk (Raichur district) and in November 1972 a male was shot on the same tank. Though rare, this pretty pochard seems to visit reedy tanks in Karnataka regularly in small numbers in winter.]

Nettapus coromandelianus (Gmelin) : Cotton Teal

I have only seen this duck twice in Sandur, on both occasions at the tank near Bandri. A party of seven was present in April 1963 and twenty teals were noted in November the same year. It is also reported from the tanks at Kereyaginahalli and Shivpur by A.M.G.

Elanus caeruleus (Desfontaines) : Blackwinged Kite

One record only, of a single bird flying over cultivation near Shivpur tank on June 19, 1970. Krishnan mentions seeing it occasionally near Sushilanagar and Lakshmipur in the valley.

Milvus migrans (Boddaert) : Pariah Kite

A fairly common resident in Sandur though not in very great numbers. During the last week of December (1965) which is the breeding season of this kite in south India, I observed several pairs at Sandur and along the route from Bangalore to Sandur engaged in what I believe is the courtship behaviour of this raptor. It consisted of the pair, soaring fairly high up in the air, indulging in aerobatics in which one bird (the male ?) would ascend a little higher and then ' dive-bomb ' the lower bird in a spiralling stoop causing the latter to take ' evasive action '. Such behaviour was observable all through the day during the breeding season, when it seems to be more frequently practiced than during other months of the year. Ali and Ripley (1968) mention this type of mannerism for this kite but do not associate it particularly with its courtship behaviour.

Haliastur indus (Boddaert) : Brahminy Kite

Krishnan states that though not common, this kite definitely occurs within the valley soon after the rains when he has watched them fishing for tadpoles at inundated flats at such times. Reported as observed near the Kereyaginahalli tank by A.M.G. I have not seen it within the taluk but noted one bird soaring above a nullah in the outskirts of Kudligi in August 1972.

Accipiter badius (Gmelin) : Shikra

A breeding resident throughout the Sandur area and fairly common. Once seen swooping down on a jungle babbler sitting in a sparsely foliaged bush on the bank of a nullah near Yeshwantnagar. Couples are often observed soaring high over cultivation in large circles. In June 1970, two immature shikras were seen harassing a group of yellow-wattled lapwings in the valley. The lapwings took to wing and retaliated fiercely by diving at the hawks, all the time keeping up their screaming calls.

Butastur teesa (Franklin) : White-eyed Buzzard-Eagle

This common raptor of the Indian plains seems widely but thinly distributed all over the taluk, including the hills. I have found the white throat patch with the dark central stripe through it a most reliable guide, when visible, to its identification in the field.

Hieraaetus pennatus (Gmelin) : Booted Hawk-Eagle

One record only, of a single bird seen perched on the stump of a dead tree beside a nullah in the valley in December 1965. When approached it took to wing and soared about in circles, slowly ascending. In flight, a small white patch on each side at the base of the neck near the wing base is a good identification mark in the field, when visible clearly.

Aquila rapax (Temminck) : Tawny Eagle

According to Krishnan, this eagle, common in the Guntakal downs (Andhra Pradesh), strays into Sandur occasionally.

[Several other large and medium-sized hawks and eagles have been observed on many occasions in Sandur by the author, but owing to the difficulty in identifying without doubt this confusing complex of birds in the field more details are not available here.]

Torgos calvus (Scopoli) : Black King Vulture

A single record, from Yeshwantnagar, of a solitary individual sitting atop a huge neem tree in the company of some whitebacked vultures. There have been several reports of late that this vulture is becoming very scarce, especially in the south. My observations in recent years fully endorse this point of view. In the last five years, I have only some three to four sightings on record. It may not be out of place here to mention that one king vulture was seen along with whitebacked and white scavenger vultures sunning themselves on a dusty path in the Bandipur Sanctuary (Mysore district) in June 1970. I feel the cause for the decline of this huge vulture in recent years needs to be studied.

Gyps bengalensis (Gmelin) : Indian Whitebacked Vulture

The most familiar vulture in Sandur, most often seen soaring high in the air with effortless ease.

Neophron percnopterus (Linnaeus) : White Scavenger Vulture

Another fairly common vulture in Sandur, often teaming up with whitebacked vultures at a carcass or in the air.

Circus spp. : Harriers

This is another group which presents problems in the correct identification of its members, especially of females and immatures. Harriers, however, are not very common in Sandur and I have only a couple of records of unidentified females flying low over fields in the valley in characteristic fashion.

Circaetus gallicus (Gmelin) : Short-toed Eagle

Krishnan informs me that this eagle occurs, though rarely, in Sandur and recollects how he once freed one of his racing pigeons from the clutches of this eagle in Sandur.

[The Osprey *Pandion haliaetus* (Linnaeus) was seen flying high above the Tungabhadra river near a place called Anaigudi near Hampi (Hospet taluk, Bellary district) on February 6, 1968. It was in bad plumage and looked to be in moult.]

Falco biarmicus jugger J. E. Gray : Laggar Falcon

I have a single sight record of the Laggar *Falco biarmicus jugger* J. E. Gray, when a single bird was seen perched on a tree on the banks of a nullah in the valley on December 26, 1965. The thin dark cheek-stripe diagnostic of the above race was clearly noticeable. Krishnan has also seen it in Sandur.

Falco peregrinus Tunstall : Peregrine Falcon

While watching the Booted Hawk-Eagle in the valley in December 1965, this falcon was also seen soaring in the air in large circles. It then only slightly drew in its wings and just shot out of sight heading towards the crags on the eastern hills. The speed which this renowned falcon can achieve is truly fantastic and has to be seen to be appreciated. Several inaccessible, almost vertical craggy spots on the Sandur hills can offer excellent breeding places for this falcon (resident breeding race : *Falco peregrinus peregrinator* Sundevall) and more careful observation could well reveal nests of the Shaheen within Sandur. Krishnan has also observed the Shaheen Falcon in Sandur.

Falco tinnunculus Linnaeus : Kestrel

A fairly common winter migrant to the Sandur valley, seen soaring or hovering characteristically over cultivation or thin jungle.

Francolinus pictus (Jardine & Selby) : Painted Partridge

Rare, only observed in thin scrub adjacent to cultivation near Yeshwantnagar on the western plain outside the hills. Krishnan mentions seeing it on Kumaraswamibetta and says it perches on tops of trees to call. Neginhal (1971) saw these near the rest house at Shingtalur.

Francolinus pondicerianus (Gmelin) : Grey Partridge

Common in the valley and plains, but not noted at any elevation on the hills. The long grass flanking the numerous nullahs provide very good cover for this partridge. Seen near the rest house at Shingtalur (Neginhal 1971).

Coturnix coturnix (Linnaeus) : Grey Quail

One record of a party of four of these migrant quails seen scuttling off into long grass bordering a road on one of the hillocks in the valley, in winter. Neginhal (1971) reports having seen them near the rest house at Shingtalur in February.

Coturnix coromandelica (Gmelin) : Blackbreasted Rain Quail

Not very common in Sandur, seen only near Yeshwantnagar on the western plains. Coveys are often seen searching for food among manure heaps dumped in fields, especially soon after a shower.

Perdicula asiatica (Latham) : Jungle Bush Quail

This is by far the most abundant and widely distributed quail in Sandur, occurring on the plains, in the valley and on the hills. The sight of these quails trooping down to their roosting place almost punctually every evening in single file is most heart-warming. Altogether an extremely interesting bird to observe and study. *Perdicula asiatica vellorei* was described as new by Abdulali & Reuben (1964) from specimens collected at Vijayanagar (Hampi, Bellary district) and several other localities. However, the subspecies is not mentioned in the INDIAN HANDBOOK (Ali & Ripley 1969). Abdulali (1969) placed two examples taken at Vijayanagar with this species but was uncertain of its subspecific identity.

[Two examples of the Rock Bush Quail *Perdicula argoondah* (Sykes) collected at Vijayanagar by G. C. Shortridge were placed with the race

P. a. salimalii Whistler (Abdulali 1969, 1971) and are in the collection of the Bombay Natural History Society. This race is separated on the basis of its bright brick-red upper plumage and is supposed to be confined to Chitradurga (Chitaldrug) district in east-central Karnataka the specimens from Vijayanagar extending its range a little further north.]

Galloperdix lunulata (Valenciennes) : Painted Spurfowl

One of the commonest game birds in the forested parts of the valley and the hills. It often sought refuge in trees while I was pursuing it and I have come across birds roosting in short trees well after dusk. This spurfowl is addicted to gleaning spilt grain on the dusty hill roads, usually in the evenings.

Gallus sonneratii Temminck : Grey Junglefowl

Uncommon and sporadic, only occasionally seen on the hills where it seems to be restricted to the open forest ; no records from the valley or the plains.

Pavo cristatus Linnaeus : Indian Peafowl

This stately bird was once very common in Sandur some years ago especially as it was protected in the erstwhile princely state. Now one can see it only near the shrine of Shri Karthikswami on the Deogiri range with any amount of frequency. It is subjected to much poaching and persecution, being hunted for its excellent flesh and for the wonderful 'tail' feathers. The peafowl also gleans spilt grain from dusty hill roads in the evenings. Neginhal (1971) reported seeing peafowl commonly in herds on an island in the Tungabhadra near Shingtalur in February.

Turnix sylvatica (Desfontaines) : Little Bustard-Quail

In February 1968, several birds were flushed, singly, on three separate occasions, from the dense tangle of vegetation on the nullah banks littered with fallen leaves, in the valley. One of these was shot and identified as this species.

[Four examples of the Indian Bustard-Quail *Turnix suscitator* (Gmelin) were taken at Vijayanagar in July and are in the Bombay Natural History Society's bird collection (Abdulali 1969).]

Amaurornis akool (Sykes) : Brown Crake

A single record, of a solitary bird hunting for food on the edges of a nullah flanked by thick bushes, in the valley a little before sunset. I watched this crake for quite some time retreating into the interior of the bushes at the slightest alarm, only to reappear stealthily a little further up the water-filled streamlet, all the time jerking its stubby tail.

Amaurornis phoenicurus (Pennant) : Whitebreasted Waterhen

Fairly common around the tanks and the many nullahs which fill up after the rains in the valley and plains.

Gallinula chloropus (Linnaeus) : Indian Moorhen

Krishnan saw this moorhen frequenting discontinuous pools of water along the Narihalla near Taranagari. It was recorded on the Tungabhadra river near the reservoir (Neginhal 1971).

Fulica atra Linnaeus : Coot

Reported from the tank at Kereyaginahalli by A.M.G. but not seen in Sandur by me.

Vanellus indicus (Boddaert) : Redwattled Lapwing

This plover is not uncommon in Sandur, keeping near tanks and nullahs with some amount of water. Also a crepuscular and nocturnal bird, its unmistakable 'did, did-he-do-it?' is a familiar sound in the night.

Vanellus malabaricus (Boddaert) : Yellow-wattled Lapwing

Frequently seen in the valley and plains in open dry country, only coming to water to quench its thirst. A much quieter bird than the Redwattled Lapwing but equally as attractive. See also under Shikra.

Charadrius dubius Scopoli : Little Ringed Plover

These little plovers were seen in small numbers on the Shivpur tank during December 1966. Probably visits other tanks in Sandur regularly each winter.

Tringa nebularia (Gunnerus) : Greenshank

One record only of a single bird at Shivpur tank on December 3, 1971. May winter on other tanks in Sandur in limited numbers. I saw two greenshanks at the tank near Chilkanhatti in February 1968.

Tringa ochropus Linnaeus : Green Sandpiper

Least numerous of the three sandpipers seen by the author in Sandur. Found singly or in small groups around small pools and water-filled depressions away from the main tank. Winter visitor in very small numbers.

Tringa glareola Linnaeus : Spotted Sandpiper

The most abundant sandpiper in Sandur in winter distributing itself on nearly all the tanks in the plains and valley. Its eye catching spotted upperparts, long dainty legs and exquisite slender form make it a delight to watch as it trips over the muddy edges of tanks in search of food. In character it is exactly opposite to the Green Sandpiper, preferring company and being easily approachable. Four of these waders were noted in February 1968 at the Chilkanhatti tank by me. Neginhal (1971) saw them on the banks of the Tungabhadra near Shingtalur in February.

Tringa hypoleucos Linnaeus : Common Sandpiper

A rather common wintering sandpiper to the tanks in Sandur, and one of the earliest migrants to arrive here. Extremely tame and confiding and also prone to a solitary habit. Seen on the Tungabhadra river bank near Shingtalur in February (Neginhal 1971).

Capella spp. : Snipe

Another group which presents problems in correct identification in the field. I have flushed several solitary birds from the wet grassy margins of Shivpur tank in winter but have not been able to identify them down to species with certainty.

Himantopus himantopus (Linnaeus) : Blackwinged Stilt

A regular and fairly common winter visitor to the tanks in Sandur. A party of 10-15 birds is invariably present during the winter months at Shivpur tank. Four stilts were seen by the author at Chilkanhatti tank in February 1968 and Neginhal (1971) saw them on the banks of the Tungabhadra near Shingtalur.

Burhinus oedicnemus (Linnaeus) : Stone Curlew

Shy and secretive ; apparently rare in Sandur, having been recorded only once in the valley by the author. Krishnan states it is not uncommon in the valley and he has often heard it calling at night over Sandur town. Two examples, assigned to the subspecies *B. o. indicus* (Salvadori), present in the collection of the Bombay Natural History Society (Abdulali 1970), were collected from Bellary.

[Neginhal (1971) saw the Whiskered Tern *Chlidonias hybrida* (Pallas) flying to and fro over a stretch of the Tungabhadra near Shingtalur in February. I saw a Blackbellied Tern *Sterna acuticauda* J. E. Gray also on the Tungabhadra near Anaigudi in February 1968.]

Pterocles exustus Temminck : Indian Sandgrouse

According to A.M.G. this sandgrouse occurs in Sandur, but I have never seen it here. However it should be fairly common in the dry open areas of the taluk.

Pterocles indicus (Gmelin) : Painted Sandgrouse

I have only one record of a pair seen in the dry mid-eastern part of the Sandur valley. Four examples of the typical race *P. i. indicus* (Gmelin) obtained from Vijayanagar and deposited in the collection of the Bombay Natural History Society include two females with strongly rufous upperparts and wing coverts and are held to be strikingly different (Abdulali 1971).

Treron phoenicoptera (Latham) : Yellowlegged Green Pigeon

Affects trees in fruit (especially of the genus *Ficus*) throughout the year in the valley and on the hills in groups of 10-20 or more. This attractive pigeon is easily identified on account of its *yellow* legs, unlike those of any other green pigeon in India.

Columba livia Gmelin : Blue Rock Pigeon

A common resident in Sandur affecting rocky areas on the hills, on buildings, in wells, and the like. A large breeding colony exists on the gorge formed by the Narihalla cutting through the western range of hills.

Streptopelia decaocto (Frivaldszky) : Indian Ring Dove

An abundant resident, more common in the drier country in the plains and valley. Neginhal (1971) saw this dove on one of the islands in the Tungabhadra near Shingtalur.

Streptopelia tranquebarica (Hermann) : Red Turtle-Dove

This small dove is fairly common in the valley especially in winter when its numbers are probably augmented by influx of outside populations. Affects the tree-lined nullahs in the valley and flies out to adjacent fields to feed. The females are apt to be mistaken for those of the Ring Dove. This is the least common of the four doves within the valley.

Streptopelia chinensis (Scopoli) : Spotted Dove

Extremely abundant wherever cultivation and groves of trees are present together with a water source nearby. The shady tree-lined nullahs in the valley and outside it attract teeming numbers of this dove, partial to moister facies, hence dominating the valley as far as the doves are concerned. Also occurs in good numbers on the hills.

Streptopelia senegalensis (Linnaeus) : Little Brown Dove

I think this is the commonest dove in the taluk as a whole, but is more abundant in the drier open country in the plains where it somewhat appreciably replaces the preceding species. Also occurs in fair numbers in the valley and on the hills. Comparatively easier to approach and less shy than other doves, it is common on trees around habitation. I have also seen it in large numbers around Hospet and Bellary. Neginhal (1971) observed them on an island in the Tungabhadra near Shingtalur.

Psittacula eupatria (Linnaeus) : Alexandrine Parakeet

Krishnan says a large parakeet, possibly this species, occurs in Sandur. I have not seen it here.

Psittacula krameri (Scopoli) : Roseringed Parakeet

Common and well distributed all over the extensively cultivated valley and a menace to agriculture. An extremely destructive bird, it feeds on several grain and fruit crops. I have seen parakeets cut off whole ears of jowar and bajra, fly on to adjacent trees to pick off a part of the grains, discard the rest of the earhead and go back to the standing crop to cut off yet another! Two parakeets were observed eating flowers and buds of a silk-cotton tree (*Bombax ceiba*) in the valley in February 1968. An especial item of food here is the green fruit of the neem tree (*Azadirachta indica*). Neginhal (1971) saw these birds near the rest house at Shingtalur.

Psittacula cyanocephala (Linnaeus) : Blossomheaded Parakeet

Almost as common as the preceding species in the valley and equally as destructive to grain and fruit. The proximity of forest to cultivated areas in Sandur being very amenable to this beautiful parakeet, it is found in much larger numbers here than elsewhere in the Deccan.

Loriculus vernalis (Sparrman) : Indian Lorikeet

Though I have no knowledge of this little psittacine in Sandur, Krishnan tells me that he has definitely observed lorikeets in Sandur. From the account of this species in the INDIAN HANDBOOK (Ali & Ripley 1969), it appears that this lorikeet is not found outside the coastal strip and ghats in the west and the ghats in the east, in the southern peninsula. In this light, the record by Krishnan from Sandur is very interesting and it only remains to confirm its occurrence and to establish whether it is resident here or just a local migrant.

Clamator jacobinus (Boddaert) : Pied Crested Cuckoo

I have but a single record, of two birds seen in bushes flanking a nullah at the base of the hills near Yeshwantnagar on 30 May 1964. Whistler (1928) discusses the status of this species in the region.

Cuculus varius Vahl : Lesser Hawk-Cuckoo

Fairly common in the valley, the birds keeping well inside densely foliaged trees, hence difficult to observe. Their unmistakable calls are a familiar sound during the rains.

Eudynamys scolopacea (Linnaeus) : Koel

A familiar and well distributed resident throughout the better wooded areas of the taluk, particularly in the valley and on the hills. Its monotonous ' ku-oo, ku-oo . . . ' on an ascending scale during the hottest months, though pleasant to the ear in the early mornings, becomes almost unbearable in the afternoons. Krishnan comments that he found it not very common in Sandur.

Taccocua leschenaultii Lesson : Sirkeer Cuckoo

Not uncommon on the grassy scrub-and-bush covered foothills in the valley as well as on the hills. A ground frequenting sombre-coloured cuckoo with a striking red bill. Ali and Ripley (1969) do not specify Karnataka as being within the range of this bird in the INDIAN HANDBOOK although it is recorded by them from all other states in the south. This observation therefore is probably the first authentic report of the Sirkeer Cuckoo from Karnataka[6].

Rhopodytes viridirostris (Jerdon) : Bluefaced Malkoha

Though I have not observed this cuckoo in Sandur, Krishnan states he has positively seen it in bushes along the Narihalla. This species is usually called the Small Greenbilled Malkoha, but I adopt Bluefaced Malkoha in concordance with Henry (1955) to prevent confusion with the (Larger) Greenbilled Malkoha *Rhopodytes tristis* (Lesson).

Centropus sinensis (Stephens) : Large Crow-Pheasant

Another common resident of the well wooded areas in Sandur. Favours the vicinity of dark mango groves and the like. Neginhal (1971) saw it near the rest house at Shingtalur.

Otus scops (Linnaeus) : Little Scops Owl

According to Krishnan this tiny owl occurs in Sandur. I have not seen it here.

Otus bakkamoena (Pennant) : Collared Scops Owl

Observed in Sandur by Krishnan but not recorded by me in the taluk.

Bubo bubo (Linnaeus) : Great Horned Owl

Two individuals of this large owl were heard and seen at midnight by Krishnan near the Narasimhaswami gorge (where the Narihalla cuts through the western ranges of hills).

Bubo zeylonensis (Gmelin) : Brown Fish Owl

One was seen by Krishnan near the Narasimhaswami gorge and I have also recorded one near a tank in the western plains, in the night.

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[6] SÁLIM ALI (1943 : The Birds of Mysore. *J. Bombay nat. Hist. Soc.* **44** : 10), has a sight record of a pair in heavy thorn scrub in a ravine at Satnur.—EDS.

Glaucidium radiatum (Tickell) : Jungle Owlet

I have no knowledge of this owlet in Sandur but am told by Krishnan that it occurs here.

Athene brama (Temminck) : Spotted Owlet

This delightful little owlet is common and widely distributed throughout the taluk. During the day pairs may be seen resting in shady trees along the nullahs or in mango orchards. Frequently seen in and around habitation.

[I seem to have rather overlooked members of the owl family in Sandur though several owls were occasionally 'caught' in the headlights while driving in the night through jungle. Such fleeting glimpses unfortunately could not result in their identity being legitimately established.]

Caprimulgus asiaticus Latham : Little Nightjar

The only nightjar seen or heard by the author in Sandur. Common and widely distributed all over the taluk, its distinctive call a familiar sound in the night. Prone to sit amongst littered leaves on the stony nullah beds during the day where they are remarkably obliterative. Several are bound to be put up in the course of an extended ' nullah-bed excursion '.

Apus affinis (J. E. Gray) : House Swift

Large numbers of these small swifts are commonly seen hawking insects in the air above the towns and villages. Nests in colonies under eaves of large buildings. Krishnan found this swift especially common around Krishnanagar.

Cypsiurus parvus (Lichtenstein) : Palm Swift

A few of these slender brown swifts were seen hawking insects in the air above the Palace and the adjacent Shivpur tank. Some six palm swifts were observed flying about near the Tungabhadra at Anaigudi in February 1968. They were also noticed to shoot up into the folds of a dried-up hanging palmyra leaf and come out almost immediately (building ?).

Hemiprocne longipennis (Rafinesque) : Crested Tree Swift

Seen along with the palm swifts flying gracefully in the air above the Palace and the Shivpur tank.

[One Lesser Pied Kingfisher *Ceryle rudis* (Linnaeus) was seen by the author on the Tungabhadra near Anaigudi in February 1968.]

Alcedo atthis (Linnaeus) : Small Blue Kingfisher

Said to occur about some nullahs by A.M.G. ; never seen in Sandur by me. Seen on the banks of the Tungabhadra by Neginhal (1971).

Halcyon smyrnensis (Linnaeus) : Whitebreasted Kingfisher

Common and resident in Sandur in all locations preferably near water. In flight its brilliant blue wings outshine even those of the Indian Roller.

Merops philippinus Linnaeus : Bluetailed Bee-eater

A regular winter visitor in small numbers to the Sandur valley where it is seen unfailingly near Shivpur tank. Here it perches on the topmost branches of the large tamarind trees overlooking the tank and launches aerial sallies after winged insects, notably large Anisopteran dragonflies.

Merops orientalis Latham : Small Green Bee-eater

An extremely common resident within and outside the valley and on the hills. Uses varying types of perches in open country, from treetops and electric wires to clods of earth from where it darts after flying insects. Neginhal (1971) saw a group of these bee-eaters on the banks of the Tungabhadra.

Coracias benghalensis (Linnaeus) : Indian Roller

Another very common bird of cultivation and open country, invariably seen perched on electric wires. Together with the Green Bee-eater and black drongos dominates the avian scene in such situations. Neginhal (1971) saw it near the rest house at Shingtalur in February.

Upupa epops Linnaeus : Hoopoe

A remarkable bird, resident and fairly common all over the taluk. Frequents open cultivation where it may be seen looking for food on the ground in its characteristic fashion. Nests in holes in walls of buildings. Recorded near the rest house at Shingtalur (Neginhal 1971).

Tockus birostris (Scopoli) : Grey Hornbill

Inhabits the better forested parts of the taluk, venturing into mango orchards in fruit to feed. Also affects fig trees laden with fruit along with a multitude of other frugivorous birds. Its slow, almost reptilian movements in fully foliaged trees often go unnoticed but the shrill kite-like squeal never fails to locate it.

Megalaima zeylanica (Gmelin) : Large Green Barbet

Curiously uncommon, seen only in the hills with any regularity. One bird was noted along with yellowlegged green pigeons feeding on ripe figs on the Ramandrug range.

Megalaima haemacephala (P. L. S. Müller) : Crimsonbreasted Barbet

The 'Coppersmith' is resident and very common in Sandur in lightly wooded areas and on large trees near habitation. Fig trees in fruit never fail to attract it.

Jynx torquilla Linnaeus : Wryneck

One record only, of a single bird seen on December 29, 1965 near a nullah in the valley.

Dinopium benghalense (Linnaeus) : Lesser Goldenbacked Woodpecker

The only woodpecker seen in Sandur by me. It is fairly common in the valley and on the hills in well wooded situations.

Picoides mahrattensis (Latham) : Yellowfronted Pied Woodpecker

Reported as occurring in Sandur by Krishnan but not seen here by me.

Pitta brachyura (Linnaeus) : Indian Pitta

This splendidly plumaged ground bird is often seen in the thick vegetation lining nullahs. Probably only a winter migrant to Sandur but I have records of the Pitta from Sandur as late as May and even the first week of June.

[Koelz (1947) took four specimens of the Singing Bush Lark *Mirafra javanica* Horsfield from Hospet in March which he described as a new race—*M. j. bangsi*, now synonymised with *M. j. cantillans* Blyth.]

Eremopterix grisea (Scopoli) : Ashycrowned Finch-Lark

This little lark is mainly found in the drier, more open parts of the taluk in paris or small parties. In January I saw a small flock of reddish larks come down for a drink at one of the nullahs in the valley. On close observation, however, I found that the brick-red coloration was not original but only a coating of red soil probably acquired in the process of a dust bath. One male was obtained in March at Hospet by Koelz (1947).

Ammomanes phoenicurus (Franklin) : Rufoustailed Finch-Lark

Occasionally seen in the same type of biotope as the preceding species. Pairs are seen feeding on the ground in scrub or fallow fields. Koelz (1947) secured a female from Hospet on March 25, 1937, which he placed with the nominate subspecies *A. p. phoenicurus* (Franklin). According to the INDIAN HANDBOOK (Ali & Ripley 1972) this race does not occur in Karnataka at all but is replaced south of *c.* 15°N. latitude by *A. p. testaceus* Koelz, the type of which came from Salem in Tamil Nadu.

Alauda gulgula Franklin : Small Skylark

Krishnan observed a small skylark in Sandur, which he thinks was this species, singing on quivering wings, high in the air in characteristic fashion.

[A female Dusky Crag Martin *Hirundo concolor* Sykes was taken at Hospet in March (Koelz 1947).]

Hirundo smithii Leach : Wiretailed Swallow

Fairly common in Sandur, always seen near water hawking insects in the air. A trim and neat swallow with long ' wires ' in the tail not readily visible in flight but the pure white underparts are suggestive pointers to its identity. A male was taken at Hospet in March (Koelz 1947).

Hirundo daurica Linnaeus : Striated Swallow

Resident and common, in fact the most abundant swallow in Sandur. Its numbers are increased in winter through the arrival of migrant populations.

Lanius excubitor Linnaeus : Great Grey Shrike

Stray individuals only noticed in the eastern plains. This shrike has not been recorded in the valley or on the western plains but it must surely occur in the latter. According to the INDIAN HANDBOOK (Ali & Ripley 1972) this shrike is not recorded in Karnataka south of Belgaum. It is in fact a fairly common bird throughout the Karnataka ' maidan ' *in suitable biotope* (Ghorpade, 1973).

Lanius vittatus Valenciennes : Baybacked Shrike

The commonest shrike in Sandur, frequenting all types of terrain in the valley and plains to the top of the hills.

Lanius schach Linnaeus : Rufousbacked Shrike

Fairly abundant in open country and scrub in the plains and valley, often seen side by side with the preceding species. In most individuals here, the rufous of the rump and lower flanks does not extent further up the back. Koelz (1947) took a male and two females of the race *L. s. caniceps* Blyth at Hospet in March.

Lanius cristatus Linnaeus : Brown Shrike

This shrike is a regular cold weather visitor to Sandur and is found singly in scrub, cultivation and the edges of forest. Duller in plumage than other shrikes, but is itself a very handsome bird.

Oriolus oriolus (Linnaeus) : Golden Oriole

This splendid bird is a familiar sight in Sandur at all elevations in the hills, valley and plains. It affects forest and field alike with a preference for the shady mango groves. A shy and retiring bird, it keeps to taller and fuller foliaged trees as a rule. It appears to be only a winter visitor here.

Oriolus xanthornus (Linnaeus) : Blackheaded Oriole

One record only of a single bird in the company of several golden orioles perched on top of a huge mango tree in the valley.

Dicrurus adsimilis (Bechstein) : Black Drongo

This pugnacious bird is commonly met with almost everywhere in Sandur including on the hills. It often accompanies grazing herds of cattle, using their backs as a vantage point from where it darts after insects disturbed by the animals. Neginhal (1971) noted it near the rest house at Shingtalur.

Dicrurus caerulescens (Linnaeus) : Whitebellied Drongo

Recorded only once from the Sandur valley when a solitary bird with a distinct white belly was seen sitting on a tree in the middle of a field near a tree-and-shrub choked nullah. Apparently a scarce resident in Sandur, but Krishnan found it fairly common at Ramgad on the Ramandrug range of hills. Campbell (1906) found nests of this drongo on the Ramandrug range.

[Krishnan observed the Greyheaded Myna *Sturnus malabaricus* (Gmelin) to be common at Tungabhadra, feeding on ripe banyan figs.]

Sturnus pagodarum (Gmelin) : Brahminy Myna

This attractive myna is a common breeding resident and is frequently seen in all types of habitat, mainly near cultivation and habitation. One bird was seen feeding on flower nectar of a silk-cotton tree, *Bombax ceiba*, in the valley in February. Koelz (1947) took a male at Hospet in March ; several were seen on trees surrounding Chilkanhatti tank in February by the author.

Sturnus roseus (Linnaeus) : Rosy Pastor

I have never seen this migrant anywhere in the taluk but Krishnan (1955) writes—' Rosy Pastors arrive in thousands in the Bellary country outside the Sandur hills about September-October. No crop in that area is then ripe, but the birds are probably still to be found there in November when a few early heads of *jowar* may be available to them. By December they appear to have quit. The remarkable thing is that they *never* cross the Sandur hills into the Sandur area where grain is available to them in plenty. On this point I am certain, but having been only an occasional visitor to the Bellary area outside the Sandur hills, I have formed only rough impressions of the movements of the Rosy Pastors there.' Abdulali (1947) discusses the movements of this bird in India.

Acridotheres tristis (Linnaeus) : Indian Myna

One of the commonest birds in Sandur especially about habitation and open country. Being omnivorous it competes with the crows and house sparrows for scraps thrown out of houses. Nests in holes in buildings, old wells and such like. Noted near the rest house at Shingtalur (Neginhal 1971).

Dendrocitta vagabunda (Latham) : Indian Tree Pie

This bird is a common resident all over Sandur from the forest-covered hills to village groves and scattered trees in the plains. An attractive avian, one is not quite prepared for its harsh calls completely different from the liquid ' bob-o-link ' uttered with body arched and tail tucked under, which helps to locate it in some leafy tree. It has three other types of calls—a raucous ' crrrh ', a crow-like ' kak, kak, kak . . . . . and another peculiar note emitted with feverish bobs of the head.

Corvus splendens Vieillot : House Crow

In Sandur, this crow is found synonymous with the town and villages but is much less common than the following species especially in open country. Its nests are parasitised by the Koel who for ages has been fooling the seemingly ' intelligent ' crow into hatching its eggs and rearing its young. Devours the ripe fruits of fig trees with obvious relish, though clumsy in the act.

Corvus macrorhynchos Wagler : Jungle Crow

Certainly more numerous than the House Crow, inhabiting almost all types of terrain including the hills. When in good plumage it is a coarsely handsome bird with shining black feathers and a strong bill. A useful scavenger of refuse in and around habitation but sometimes destructive to grain and fruit crops. Also feeds on fruit of trees of the genus *Ficus*.

Tephrodornis pondicerianus (Gmelin) : Lesser Wood Shrike

Frequently seen singly or in pairs in and outside the valley. Affects the trees and shrubbery along nullah banks and also scattered tree-and-bush country on the foothills. Has a pleasant musical call and hunts insects in the manner of a flycatcher. Koelz (1947) secured a male at Hospet in March 1937.

Coracina novaehollandiae (Gmelin) : Large Cuckoo-Shrike

This fine bird has a liking for tall stately trees and is not uncommon in the valley.

Coracina melanoptera (Rüppell) : Blackheaded Cuckoo-Shrike

Seen only once near the tree-choked nullah at Yeshwantnagar in May 1964. Its light grey plumage seemed almost blue in the dark interior of the nullah but the black head was distinct. One male was obtained at Hospet in March (Koelz 1947).

Pericrocotus cinnamomeus (Linnaeus) : Small Minivet

Small groups of four to twelve birds are frequently observed on larger trees hunting insects and constantly uttering feeble musical calls. Fairly common in dry open forest and groves of trees in the valley.

Aegithina tiphia (Linnaeus) : Common Iora

A very common and delightful little resident of the Sandur area. It has a bewitching mellow whistle, surprisingly loud for so small a bird. Affects well wooded open country with groves of large trees and also the forested hills. In breeding plumage the male is a striking golden yellow and black bird, its antics on trees an immense joy to watch. Koelz (1947) took a male in March at Hospet.

Chloropsis cochinchinensis (Gmelin) : Jerdon's Chloropsis

A.M.G. reports this bird as resident and breeding in Sandur but I have not seen it here. Krishnan mentions seeing it along a nullah in the valley.

Pycnonotus jocosus (Linnaeus) : Redwhiskered Bulbul

A somewhat scarce and local resident, keeping to moister and more forested areas, thus being more familiar on the hills.

Pycnonotus cafer (Linnaeus) : Redvented Bulbul

Extremely abundant everywhere and resident. Wild fig trees in fruit invariably attract this species which gorges itself on the delicacy. It is no doubt an important dispersal agent for the Sandal tree *Santalum album*, found all over Sandur. Several of these bulbuls were seen by the author near the tank at Chilkanhatti in February 1968. Koelz (1947) secured a male in March at Hospet.

Pycnonotus xantholaemus (Jerdon) : Yellowthroated Bulbul

C. L. Wilson shot and identified one of this species at Bellary on June 13, 1901 and also noticed some 20 pairs frequenting the rocky hills there. He also took a nest on June 23 the same year and felt that June-July was the breeding season of these bulbuls there (Allen 1908). This is again quoted by Whistler and Kinnear (1932b) in their report on the Eastern Ghats bird survey. Whistler (*in* Ali 1942) refers to the Eastern Ghats survey report and comments further—' this bulbul . . . . is apparently much overlooked because of its skulking habits and the fact that the region it inhabits has not received much attention from ornithologists,

. . . . a specimen was collected at Ramandrug on 6 May 1919 (?) by Mr. E. H. Pooler . . . . ' Ali and Ripley (1971) include only Chitaldrug (Chitradurga) and Bangalore districts as within the range of this uncommon bulbul, possibly overlooking the above reports from Bellary district. I have not seen this rare bulbul in Sandur and Pooler's specimen from Ramandrug in the hills is the only record of the bird from the taluk.

Pycnonotus luteolus (Lesson) : Whitebrowed Bulbul

Another familiar bulbul in Sandur but not as abundant as the Redvented. It prefers open country and cultivation but also affects the tree-lined nullahs in the valley. Possesses a loud call which is a good indication of its presence on walks.

Pellorneum ruficeps Swainson : Spotted Babbler

One record only, of a pair hopping about on the bed of a nullah littered with fallen dry leaves near Yeshwantnagar in the western plain near the foothills of the southern range, on May 1, 1963. Ali and Ripley (1971) state that this babbler is not known from the Deccan plateau so this record is of considerable interest. The Sandur hills with their densely forested slopes provide an ideal habitat for this babbler.

Dumetia hyperythra (Franklin) : Whitethroated Babbler

Observed in small flocks in scrub near Yeshwantnagar. They keep to small bushes, hopping about in them and uttering sharp chirpy calls.

Chrysomma sinense (Gmelin) : Yelloweyed Babbler

A compact babbler with a loosely held long tail and striking yellow eyes. Keeps to the interior of bushes and thickets along nullahs and is very shy and evasive, thus being difficult to observe. Koelz (1947) shot a male of this species at Hospet in March.

Turdoides caudatus (Dumont) : Longtailed Streaked Babbler

The ' Common Babbler ' of many authors, it is decidedly uncommon in Sandur, keeping to the drier, scrub-covered areas of the western plains. Here it lives in small flocks which are seen following each other across the scrub. I prefer to call this the ' Longtailed Streaked Babbler ' as the bird is hardly common throughout its range[7]. A male was obtained on March 25 at Hospet (Koelz 1947).

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[7] The word ' common ' is best restricted to an indication of the abundance of a particular bird in a given area rather than as an English name designating a species. The latter procedure usually results in ambiguity especially among amateurs when the common name is not accompanied by the scientific name of the species. Thus the term ' Common Babbler ' in Sandur may apply either to *T. striatus* or to *T. malcolmi* depending on whether the reference is in respect of the hills or the plains respectively. If there is to be a standardisation of English names of Indian species (not for subspecies too, please, as in the INDIAN HANDBOOK), I strongly suggest elimination of the term ' common ' in favour of a more descriptive word.

Turdoides malcolmi (Sykes) : Large Grey Babbler

Very common in parties of 3-7 birds about cultivation, scrub, vegetation lining nullahs and roads, and edges of forest. Less common than the following species in the forested areas where it is rare. Frequently seen in company with the preceding species in scrub jungle. Moves about very stiffly on the ground and is very noisy and demonstrative if disturbed, the rabble taking refuge in nearby trees and keeping up a constant nasal 'goinya, goinya, goinya . . . .' which gives them their local name. Two juveniles were taken at Hospet in March by Koelz (1947).

Turdoides striatus (Dumont) : Jungle Babbler

Possibly the commonest babbler in Sandur as a whole, particularly on the forested hills where it alone rules the roost so to speak as far as babblers are concerned. Moves about in 'sisterhoods' of 6-8 individuals, feeding mostly on the ground. On the slightest alarm, the whole flock flies into the nearest tree and sets up a terrible squeaking din, gesticulating with loosely held tail and flicking wings drooping at the sides.

Turdoides affinis (Jerdon) : Whiteheaded Babbler

Somewhat similar to the preceding species in size, shape, coloration and habits but easily separated on account of its creamy-white head, dark brown breast and more musical calls. Somewhat uncommon and noted only around Yeshwantnagar in the western plains. Ali and Ripley (1971) state that this babbler is 'absent or scarce in Mysore east of the Western Ghats.' I may mention here that this babbler also occurs fairly commonly around Bangalore.

Muscicapa latirostris Raffles : Brown Flycatcher

An uncommon resident in Sandur, usually seen hunting insects in the seclusion of the numerous shady mango orchards in and outside the valley.

Muscicapa parva Bechstein : Redbreasted Flycatcher

A regular and plentiful winter visitor to the Sandur area. Each bird occupies a distinct 'territory' on arrival and is found day after day in the same stretch of garden, nullah-bank vegetation or tree-grove. I have never seen the redbreasted male either here or at Bangalore (where it is also a common migrant). It has a characteristic habit of jerking the white marked black tail upwards and at the same time uttering a curious creaky chatter.

Muscicapa superciliaris Jerdon : Whitebrowed Blue Flycatcher

One record of a single bird seen twice on the same day (April 30, 1963) in the vicinity of an overgrown nullah near Yeshwantnagar.

According to my notebook I do not seem to have noticed the white supercilium (if there was one) but the broken blue pectoral band on each side of the breast was definitely observed. A single male collected at Namadachilume (Tumkur district) in southeastern Karnataka on January 2, 1940, by Sálim Ali (1942) is the southernmost and only record of this flycatcher from Karnataka. My record is the second report of this bird from Karnataka and suggests that this flycatcher is possibly an erratic winter visitor here in favourable biotope.

Muscicapa tickelliae (Blyth) : Tickell's Blue Flycatcher

A common resident all over Sandur particularly in nullah-bank vegetation and well-wooded country. One of the prettiest of the peninsular flycatchers, it delights in perching on roots jutting out of nullah banks and launches aerial sallies after insect prey.

Muscicapa thalassina Swainson : Verditer Flycatcher

This brilliant blue flycatcher was seen only once at Shivpur in February 1968 when it flew out of a ' bakul ' (*Mimusops elengi*) tree on to an electric wire where it sat for some time, quivering its tail, before dashing back into the tree's interior.

Culicicapa ceylonensis (Swainson) : Greyheaded Flycatcher

One record only, of a single bird frequenting a shrub-lined nullah near Yeshwantnagar on October 3, 1963. Ali and Ripley (1972) state it is not found south of the Krishna river except on the Western Ghats and the Ceylon hills. I have also seen this flycatcher in winter near Yelburga (Raichur district) and it seems to occur further south (in winter only ?) than so far recorded.

Rhipidura albogularis (Lesson) : Whitespotted Fantail Flycatcher

This delightful flycatcher is met with fairly frequently in groves of trees in the valley, along nullah-bank vegetation and edges of forest, where it flits about gracefully, displaying its tail and picking up insects. A breeding resident in Sandur, also occurs on the western plain especially near Yeshwantnagar. Koelz (1947) took a female on March 25 at Hospet.

Terpsiphone paradisi (Linnaeus) : Paradise Flycatcher

A graceful flycatcher, it is resident and fairly common in Sandur. Mango orchards and shrub-laden nullahs are its favourite haunts. Very elegant in flight, its long tail feathers (in the male) floating behind as it wends its way through the dark canopy of trees.

Prinia spp. : Longtail Warblers

Parties of longtail warblers numbering from three to fifteen are frequently seen flying from bush to tree-top, in long grass, shrubs bordering cultivation and such like but are very difficult to place. They constantly utter feeble calls to each other while flitting about in search of food. These birds are difficult to identify in the field with certainty but I think *Prinia hodgsoni* Blyth and *P. subflava* (Gmelin) occur most commonly in Sandur.

Prinia socialis Sykes : Ashy Longtail Warbler

Fairly common in bushes, nullah-bank vegetation, open forest, scrub and long grass. An attractive little warbler especially when in breeding plumage. Koelz (1947) took a male at Hospet in March ; Neginhal (1971) saw them in bushes on an island in the Tungabhadra in February.

Orthotomus sutorius (Pennant) : Tailor Bird

An exceedingly common resident, principally found scrummaging in bushes and on trees in open country as well as along nullahs. Tame and confiding, it has a remarkably loud call.

Acrocephalus dumetorum Blyth : Blyth's Reed Warbler

A common winter visitor to Sandur, found hopping about in shrubbery along nullahs or tanks, generally near water. An unobtrusive warbler with a distinct pale supercilium.

Phylloscopus inornatus (Blyth) : Yellowbrowed Leaf Warbler

Noted only once in the Palace garden hunting insects on a fig tree. A distinct yellow supercilium and two wing bars suggested its identity. Probably winters here in small numbers.

Copsychus saularis (Linnaeus) : Magpie-Robin

A fine songster common around habitation, gardens and orchards. Also in cultivation interspersed with trees and along nullahs. Partial to groves of large trees but also in scrub.

Phoenicurus ochruros (S. G. Gmelin) : Black Redstart

A fairly common winter visitor, frequenting the Palace garden, orchards, cultivation and tree-lined nullahs. A beautifully coloured bird with the habit of shivering its tail constantly.

Saxicola torquata (Linnaeus) : Stone Chat

Evidently a rare winter straggler to Sandur, single birds seen occasionally in the valley in cultivation and scrub.

Saxicola caprata (Linnaeus) : Pied Bush Chat

Common and abundant in Sandur in all situations, often perched on top of a thorny bush or on telegraph wires, flicking its tail regularly. The resident race is probably *S. c. burmanica* Stuart Baker but I have one sight record of a single individual with white extending up to the breast which seemed to belong to the migrant subspecies *S. c. bicolor* Sykes. I saw this species on the banks of the Tungabhadra near Anaigudi in February. Koelz (1947) took a male at Hospet in March.

Saxicoloides fulicata (Linnaeus) : Indian Robin

One of the commonest birds in Sandur, extremely abundant everywhere but prefers the neighbourhood of cultivation and scrub interspersed with rocky areas. After a cloudburst it is one of the first feathered creatures to hop down from shelter and burst into song. Keeps its tail cocked up at an acute angle showing the chestnut under-tail coverts. Neginhal (1971) saw it near the rest house at Shingtalur; Koelz (1947) collected a male at Hospet in March.

Zoothera citrina (Latham) : Orangeheaded Ground Thrush

This interesting thrush is rarely seen, being extremely elusive and seldom venturing out from concealment under some overgrown bushes flanking a nullah. Rummages about among dry littered leaves on stony nullah beds for insects and fallen fruit.

Parus major Linnaeus : Grey Tit

One record only, of a single bird in company with some redwhiskered bulbuls in moist forest at the edge of Thayammankolla on the Ramandrug range in August 1972.

Anthus hodgsoni Richmond : Hodgson's Tree Pipit

A small party of these migrants were observed for several days affecting the Palace garden and the tamarind trees on the grassy banks of Shivpur tank.

Anthus novaeseelandiae Gmelin : Paddyfield Pipit

A common resident in Sandur in the open areas, grassland and cultivation. Gregarious, always found in loosely scattered flocks searching for food on the ground. Koelz (1947) took a female on March 24 at Hospet.

Motacilla caspica (Gmelin) : Grey Wagtail

A few individuals of this species winter at the tanks in the taluk. One or two birds sometimes enter the Palace garden.

Motacilla alba Linnaeus : White Wagtail

This wagtail is found about the tanks at Shivpur and Bandri in the winter in small numbers, walking about on the edges and wagging the tail ceaselessly.

Motacilla maderaspatensis Gmelin : Large Pied Wagtail

Not uncommon along the Narihalla, various tanks and around cultivation in the valley and plains. I saw one at Anaigudi on the banks of the Tungabhadra in February 1968.

Dicaeum agile (Tickell) : Thickbilled Flowerpecker

Not uncommon in well-wooded country especially along vegetation lining banks of the numerous nullahs. I located a nest of this species with two young on a tree with sparse reddish brown leaves beside a nullah near Yeshwantnagar in April 1963. This flowerpecker is an important dispersal agent for the plant parasites *Loranthus* and *Viscum.*

[Tickell's Flowerpecker *Dicaeum erythrorhynchos* (Latham) was obtained at Hospet in March by Koelz (1947). Not recorded so far from within Sandur limits, but it must surely occur here.]

Nectarinia zeylonica (Linnaeus) : Purplerumped Sunbird

A very common resident, found plentifully wherever flowering trees or shrubs are present. This is where the lantana bush comes as a revelation, sunbirds being very fond of its nectar. Also in gardens about habitation not unduly disturbed by the presence of humans. Koelz (1947) secured a male in March at Hospet.

Nectarinia asiatica (Latham) : Purple Sunbird

A shimmering sunbird, superbly plumaged, with a long curved bill which it inserts into flowers to sip nectar. Associates in small groups of 4-6 birds at times and may be found along with the preceding species in the country. The immature male is like the female but with a dark line running vertically down the centre in front from chin to vent. I have seen the glorious male bird chasing away large carpenter bees (*Xylocopa* sp.) visiting the same flowering tree with audible snaps of the bill. Resident and common in Sandur.

Zosterops palpebrosa (Temminck) : Oriental White-eye

Another well distributed bird in Sandur. Completely arboreal, it keeps in parties of 5-20 birds which restlessly hunt insects in densely foliaged trees or bushes in light forest, orchards, gardens and the like. Constantly utter a feeble chirpy call while feeding.

Passer domesticus (Linnaeus) : House Sparrow

Extremely abundant in the town and villages, a constant hanger-on of man. Only found in and about habitation or cultivation near villages. When the adjacent fields are in grain, large hordes of sparrows will visit them, causing considerable damage. I saw these on the banks of the Tungabhadra near Anaigudi.

Petronia xanthocollis (Burton) : Yellowthroated Sparrow

A locally distributed but common resident. I found this sparrow in great numbers affecting the central valley. From the tree and shrub bordered nullahs they would fly onto adjacent fields to feed on ripening earheads of jowar and bajra. Also ventures into the Palace garden. One bird was seen feeding on the nectar of silk-cotton (*Bombax ceiba*) flowers in the valley in February.

Ploceus philippinus (Linnaeus) : Baya Weaver

Fairly common resident, breeding during June-August, building its wonderful nests on trees overhanging nullahs, wells, ponds or tanks. Does some damage to grain crops, especially rice and jowar.

Lonchura malabarica (Linnaeus) : Whitethroated Munia

Fairly common about cultivation, dry open scrub and forest edges usually in small to large flocks. Feeds on standing grain crops doing appreciable damage.

Lonchura punctulata (Linnaeus) : Spotted Munia

This little munia is seen from time to time in small flocks and family parties about cultivation associated with light forest. Sometimes teams up with whitethroated munias to feed on ripening grain in cultivated areas. Also feeds on a large variety of grass seeds. A common breeding resident in Sandur.

DISCUSSION

The above account includes a total of 166 species recorded from Sandur taluk with an additional 16 species from other parts of Bellary district. In order to get a reasonable idea of the composition and variety of Sandur's bird life, a comparison with areas of similar dimensions and terrain would be ideal. Table 1 provides such areas together with the number of species recorded from each.

TABLE 1

SPECIES RECORDED FROM AREAS OF COMPARABLE SIZE AND TERRAIN TO SANDUR

Area	Species recorded	Reference
MADHYA PRADESH :		
Saugor (Sagar) and Damoh districts	155*	*J. Bombay nat. Hist. Soc.* **21** : 87 (1911)
Sehore (Bhopal)	294	ibid., **21** : 153 (1911)
Balaghat	162	ibid., **21** : 1158 (1911)
Pachmarhi	135	ibid., **28** : 453 (1922)
Betul	168	ibid., **41** : 286 (1941), **44** : 471 (1944)
MAHARASHTRA :		
Berar (Akola and Buldana districts)	193	ibid., **43** : 428 (1942)

* Resident birds only recorded.

Comparing the number of birds so far observed in Sandur (166) with those recorded from the localities mentioned in the table of somewhat similar terrain and size, it seems that in numbers at least, Sandur is in no way inferior. When one considers that Sandur has almost no habitats for water birds and that it is mainly an area of hill forest, open cultivation and dry scrub, a possible total of about 200-250 species would be a conservative estimate for the taluk. Only Bhopal with 294 recorded species is comparatively richer in its avifauna. My own estimate is that the 166 species recorded in this paper make up only about 60-70% of the possible total of species for this distinctive area. The noticeable omissions from the list are birds attached to inland waters like egrets, herons, storks, waders, snipe, ducks, wagtails and crakes, the paucity of such habitats in the taluk accounting for the absence of these species in Sandur. Other groups such as the diurnal birds of prey, owls, nightjars, cuckoos, warblers, flycatchers and larks must certainly make up a large proportion of the avian population especially in the hills and will need a more careful and exhaustive search.

My observations on the ornithology of Sandur have been necessarily limited, having been carried out in bits and pieces on short trips to the area over a period of ten years. Many areas in the taluk such as the eastern plains were virtually neglected and others were poorly worked for instance the highly interesting hill forests and the western plains. Only the valley was more or less fairly well studied for its avifauna but even here much more field work needs to be carried out in a more systematic manner. An extended residence in the area for a couple of years would be ideal which indicates that ' residents ' in the taluk could achieve far more than an ' occasional visitor ' like the author. Meanwhile, it is hoped that this preliminary list will serve as a broad indication of the type of bird life existing in the Sandur area and as an aid to future work on the avifauna of the taluk.

ACKNOWLEDGEMENTS

I wish to acknowledge, with pleasure, the help rendered by Mr. M. Krishnan, of Madras, in reading the manuscript and offering valuable comments and much additional and supplementary information based on his personal observations on the birds of Sandur. I am grateful to Dr. G. P. Channa Basavanna, Prof. of Entomology, University of Agricultural Sciences, Bangalore, for reviewing the manuscript. I am also thankful to my nephew, Mr. Ajai M. Ghorpade of Sandur, for many useful discussions and am greatly indebted to my uncle, Mr. Y. R. Ghorpade for his many courtesies during my stays at Sandur and for his sustained interest in this work.

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Obituary

NORMAN LOFTUS BOR

(1893-1972)

Dr. N. L. Bor. C.I.E., O.B.E., M.A., D.Sc., F.L.S., F.R.S.E., the distinguished authority on Asiatic Grasses, died on 22nd December, 1972, at the West London Hospital, after a brief illnessBorn on 2 May 1893 at Tramore, Co. Waterford, Ireland, his death at the ripe age of eighty, will be considered by many as the end of an era in Indian botany.

He took his M.A. and later D.Sc. at Trinity College, Dublin. A thesis on the vegetation of the Naga Hills, Assam, subsequently earned him a D.Sc. from the University of Edinburgh.

During the First World War, he served with the Connaught Rangers in France, Salenica and Palestine. He entered the Indian Forest Service in 1921 and during the next 27 years occupied a number of important posts, both professional and administrative ; as a Forest Officer, Botanist, Political Officer and Chief Refugee Administrator (1943-1946), and at his retirement, held the rank of Conservator of Forests.

Dr. Bor had an uncanny knack of learning the languages of the tribals of Eastern India and we have the testimony of his wife, Eleanor Constance Rundall, that he could converse effectively in as many as seven tribal languages of Assam by the time of their marriage in 1931. Her book ADVENTURES OF A BOTANIST'S WIFE published hardly five years before her death in 1957, makes entertaining reading. Her definition of a botanist is ' a species that seeks untrodden ways, often perilous, in search of . . . specimens '. This could be considered as a pointer to the character and drive of her botanist husband during their botanising in Eastern India. She narrates many anecdotes and reminiscences which depict eloquently Dr. Bor's quiet courage, foresight and presence of mind in the face of numerous hazards faced during his (and also their) travels in the rugged mountainous terrain clothed with impenetrable forests, infested with bears, elephants, leeches and dreadful insects, rather than with snakes and tigers. She narrates, how, during their travel through forest on an elephant's back, within the first six days of their marriage, she suspected her husband might be going mad, because he suddenly started scratching himself ferociously and then flung himself from the elephant and disappeared into the forest. She learnt later that he had rushed to a nearby stream to wash off the intensely irritating bristles of *Mucuna prurita*, some of which must have fallen on his neck, face and shoulders, when their elephant brushed against the creeper.

The opportunity to study the grasses in a more comprehensive manner came to Dr. Bor when he was deputed by the Government of Assam to the Kew Herbarium for three months during 1936 for training, to bring out a manual of the Grasses of Assam ; and FLORA OF ASSAM, Vol. V, the Gramineae (1940), was the result thereof. Sir Joseph Hooker's remark about the grasses of his time being 'dreadfully difficult and systematically a chaos of imperfect descriptions, erroneous identifications, confused synonymy and imbecile attempts' to study the grasses (Taylor in Bor 1960) might have stimulated the young botanist in Bor of 1936-40 to accept the challenge and to continue undiminished his interest and dedication for the study of the Asiatic grasses at Kew Herbarium, first as Assistant Director from 1948 to 1959, and then as a self-employed honorary member of the grass section from 1959 almost till his death in December 1972. Apart from his numerous publications, particularly on the vegetation of flora of Eastern India, and his books such as MANUAL OF FOREST BOTANY (1953), and BEAUTIFUL INDIAN CLIMBERS AND SHRUBS (with M. B. Raizada) (1954), his monumental work on the GRASSES OF BURMA, CEYLON, INDIA AND PAKISTAN (1960), of the FLORA OF IRAQ (1968), of the FLORA IRANICA (1970) and of the forthcoming FLORA OF CYPRUS will stand as his memorial and bear testimony to the fruits of many years of thorough and persistent labour and the splendid realization of a dream come true! While his admirers abroad, particularly those interested in the study of Asiatic Grasses, will benefit immensely from his masterly elucidation of the complexities involved in the systematics and nomenclature of one of the most difficult families of flowering plants, his younger colleagues and admirers closely associated with him at Kew during the last 24 years, in the words of Dr. W. D. Clayton, 'will remember with delight the burly figure amid a litter of specimens, dispensing fudge, German translations, and an inexhaustible supply of outrageous reminiscences. They will recall, with a sense of gratitude, that his encouragement, advice and wise counsel were also available to all who sought them . . . . We shall all miss him as a colleague and many of us will mourn him as a friend.' I consider myself extremely unfortunate that I did not arrive at the Kew Herbarium until a week after he had left it.

Dr. Bor was awarded the Paul Johannes Brühl Medal of the Royal Asiatic Society of Bengal 1945 and the Gold Medal of the Linnaean Society of London in 1962. For his distinguished services in India, he was awarded the C.I.E. in 1945 and the O.B.E. in 1957 for his services to the Kew establishment.

G. PANIGRAHI

V. K. CHARI

(1912-1972)

Vanaharam Krishnama Chari was born on 12 January 1912 at Ballampet, Cuddapah District, Andhra Pradesh. He graduated from the Christian College at Madras and after working as a school master in Andhra Pradesh joined the Society as its Assistant Curator in 1946. Under the then existing arrangement Mr. Chari was also Assistant Curator of the Natural History Section of the Prince of Wales Museum, Bombay. In 1960 Mr. Chari took over as Curator of the Natural History Section of the Museum and continued in that capacity till his death on 31 January, 1972.

A kind-hearted gentleman and a genial companion ever ready to assist anyone who needed help, his untimely death is a grievous loss to his many friends.

Mr. Chari's special interest was Herpetology and he contributed several useful papers to the Society's *Journal* which are listed below :

J. C. Daniel

The record Black Earth Boa [*Eryx johni* (Russell)] **49** : 127.

Breeding habits of *Thais bufo* (Lamarck). (*With two text-figures*) **49** : 317.

A Dhaman or Rat-Snake [*Ptyas mucosus* (Linn.)] jumping **49** : 561.

Occurrence of the fish *Danio aequipinnatus* (McClelland) in Nela Bilam-an Underground cavern in Kurnool District, South India **49** : 565.

The Great Indian Rorqual or Fin-whale *Balaenoptera indica* Blyth, off Umargam (Bombay State) **50** : 167.

Bull Frog (*Rana tigrina* Daud.) preying upon the Common Toad (*Bufo melanostictus* Schneid.) **50** : 679.

Localization of the striped variety of the Roughtailed Earthsnake—*Uropeltis macrolepis* (Peters)—to Mahableshwar **50** : 950.

Some more notes on *Uropeltis macrolepis* (Peters) with special reference to specimens from Mahableshwar (Western Ghats, Bombay) **51** : 512.

New locality record of *Rana hexadactyla* Lesson **51** : 751.

An addition to the list of Snakes of Bombay and Salsette—*Uropeltis macrolepis* (Peters)—Uropeltidae **52** : 213.

A new form of the burrowing snake, *Uropeltis macrolepis* (Peters) from Mahableshwar **52** : 901.

A blind snake from Nepal **53** : 711.

The Horned Helmet, *Cassis cornuta* Linn.—an addition to the list of Marine Gastropods of Bombay **53** : 736.

Distribution of the skink, *Riopa lineata* (Gray) **57** : 226.

A description of the hitherto undescribed tadpole of, and some field notes on the fungoid frog, *Rana malabarica* Bibron **59** : 71.

Reviews

1. THE NATURAL HISTORY OF INFECTIOUS DISEASE. By Macfarlane Burnet and David O. White. Fourth Edition. pp. 278 (13·5×21·5 cm). London, 1972. Cambridge University Press. Price £1.20.

The fourth edition of Sir Macfarlane's already well known book has been extensively revised and brought up-to-date in collaboration with Dr. David White. It is a tribute to their talents and literary skill that this revision, has not made the book more bulky, and the lucid, conversational style of the original has been retained. This is all the more impressive when it is seen that the book is full of useful information, some of which is sought in vain, even in more comprehensive treatises.

The authors have discussed, from an evolutionary and ecological standpoint, the progress of many of the common infectious diseases. The interplay between an infecting organism and the host animal or man, in the rise and decline of epidemics, as well as the influence of socio-economic factors, and of scientific advances, like the discovery of antibiotics, on health and disease, have been ably presented. A brief survey is made of advances in immunology and its importance in human disease processes. The prevalence of newer diseases, and the importance of viral infections, many hitherto of minor importance, have been examined in the light of the ecological situation. Finally, the importance, applications, and possible misapplications, of newer knowledge of microbiology, and the possible effect on human beings, e.g. in biological warfare, are considered, in a brief, but very balanced appreciation of current trends.

The charm of a book like this cannot be analysed. In addition to the obvious discussion of interplay between host and parasite, the authors cover, directly or by implication, the interplay of social and economic changes, the problems of population pressures, the importance of psychosocial factors and behaviour patterns e.g. our failure to make any impact, in spite of our knowledge, on the spread of venereal disease or on smoking habits; and many other facets of the human situation, which make for stimulating reading.

It is usual when reviewing a book of this nature to start by asking for whom it is intended. It is obviously not intended as a text-book for the medical or microbiology student, but it is a book with a very wide appeal. Because it opens up wider horizons, it can be an illuminating supplement to the standard text-books, for the student of medicine or of microbiology, as well as for the practising physician and public health worker; it can also be read with interest by the general reader who seeks entertainment and instruction 'without tears'.

It is not generally appreciated how much the get-up and presentation can affect the acceptance and the readability of a book like this for the general reader. The publishers are to be congratulated on the practical format and excellent get-up. In particular, the combination of the paper and the pleasing type face used, makes the book aesthetically satisfying and a pleasure to handle and to read.

A. N. D. N.

2. GENETIC DIVERSITY AND NATURAL SELECTION. By James Murray. University Reviews in Biology. pp. vii+128 (14×21·5 cm). With 23 text-figures. Edinburgh, 1972. Oliver and Boyd. Price £1·25 (cased £2·50).

This book is intended to be an introduction to the field of ecological genetics, and is addressed to senior undergraduate and postgraduate students, but anyone who knows the principles of genetics and is familiar with its terminology will find much of interest here.

Darwin wrote his ORIGIN OF SPECIES at a time when the laws of heredity were not known. He believed that there was a great deal of inherent variability within species, with breeding tending to eliminate differences, while selection preserved them. Now, a hundred years later, evidence has accumulated to show that Darwin was essentially correct in his views on the role of natural selection. Modern electrophoretic techniques have made it possible to investigate the extent of polymorphism in groups of enzymes known to be produced at single loci. In every species and every population investigated a large proportion of loci were polymorphic: forty-one per cent in the house mouse, sixty-three per cent in the snail *Cepea nemorails,* and fifty-four per cent in *Drosophila melanogaster.* Human blood groups have been studied; thirty-three per cent of the loci determining these are polymorphic, and the average individual is heterozygous for sixteen per cent of them.

How are these polymorphisms maintained in nature? It was believed by the post-Darwinian geneticists that there was a 'wild type' of individual, and that mutations were frequent. Selection was constantly eliminating the less advantageous mutations, while favourable ones spread in the population. This theory does not explain the many very stable polymorphisms which exist in natural populations, in which different forms have characteristic frequencies. For example, *Cepea* snails may have yellow or brown shells, the proportions of which may vary in different places. Shells from Neolithic and Bronze Age sites show the same frequencies of these morphs as do living populations of these snails in the same area. The first explanation that cames to mind is that such characters have no selective value. There is however, evidence to show that this is not true in many cases. It has been shown that heterozygosity in itself an advantage ('hybrid vigour'), but this is also not the whole answer. In one of the most interesting sections of the book Dr. Murray describes experimental evidence that frequency-dependent selection operates in nature to maintain polymorphisms. One of the ways this may happen is through predation. Predators, for example, birds, may tend to take the kind of prey they are used to, and therefore take proportionately more of the commonest form, to the selective advantage of rare variants, as long as they remain rare.

When each of two morphs is advantageous while the heterozygote between them is disadvantageous, one of two things happen. Either dominance develops, so that the harmful effects of the heterozygote are masked by the dominant character, or reproductive isolation develops which could lead to speciation. An example of the first alternative is found in the African butterfly *Papilio dardanus*, which has females which mimic a number of different models, as well as non-mimetic males and females. In mainland Africa where mimics and non-mimics occur together, there is clear dominance of one form over another in heterozygotes. In Madagascar there are no naturally occurring mimics. In crosses between mainland mimics and non-mimetic island butterflies the resulting heterozygotes are intermediate between the parent forms, showing that dominance relationships have had no chance to develop in the island population. The evidence for incipient speciation when forms are subjected to different ecological conditions is conflicting. Certainly they rapidly differentiate into distinct well-adapted forms, which are maintained in spite of breeding between them. Further research is needed in this area to show whether species can arise in this way.

Dr. Murray has dealt with a complex subject with admirable clarity and the many examples he quotes in support of his argument should be read in full.

R. R.

3. TERMITE PROBLEMS IN INDIA. Edited by Dr. M. L. Roonwal. pp. viii+82 (24×16 cm). New Delhi, 1972. Council of Scientific and Industrial Research.

This is a compilation of papers read at symposium of Termitologists of India, convened by the Council of Scientific and Industrial Research at New Delhi in March 1970. In this conference the experts have expressed their experiences in their work on termites, very briefly and in some cases have recommended measures of control and have suggested future lines of work. Taking into consideration all the papers together, they may be divided into five groups: (1) Termites affecting buildings, factories etc., (2) Resistance of some timber to termite attack, (3) Ecology and destruction of agricultural and horticultural crops and forest plantations, (4) Cytology and physiology of the insect, and (5) Taxonomy.

It is pointed out that very little work has been done of the pest from the academic point of view. There is a vast scope for physiological and Cytogenetical study of this pest. Problems on the physiology of digestion are discussed. It is also noted that very little cytogenetical work has been done in this country. Its importance is stressed and suggestions have been made as to how the Universities can help.

The taxonomy of termites was a neglected field and what has been accompalished now is only a decade's work. In this period fairly impressive results were obtained and new genera and species were added to the fauna of India. Faunistic studies have been carried out only in a small part of India and the rest of the country is yet to be surveyed.

One of the most important part of study of an insect is its life history and habits. Though the termite is found everywhere and does so much damage, practically no work has been carried out in this direction. For such a study and to carry out co-ordinated research on this important insect a unified centre has been suggested.

N. T. N.

4. PIPPA'S CHALLENGE. By Joy Adamson. pp. 175 (23×18 cm). With 14 coloured and 64 black-and-white plates. London, 1972. Collins and Harville Press. Price £2·75.

Very little is known about the cheetah. All the more reason, therefore, to be grateful to Joy Adamson for a second book about these attractive cats. Readers of THE SPOTTED SPHINX will know how Mrs. Adamson successfully rehabilitated Pippa, her pet cheetah, to life in the wild. Pippa had four litters, of which two survived to maturity. This book is mainly concerned with the fourth litter, which Mrs. Adamson continued to observe after Pippa's death. Meanwhile the three females of the previous litter were in excellent condition, and at least two of them brought up litters on their own.

According to Schaller cheetahs are solitary animals which do not defend territories but which normally simply avoid encountering one another. Thus what Mrs. Adamson refers to as 'territory' is really home range. Her female cheetahs maintained three distinct home ranges most of the time. Their occasional meetings are of interest. When mother and daughter met after months of separation both threatened each other, but the daughter gave way and rolled on her back in submission. When the same young female met her sisters, who had remained together, one greeted her, but the other snarled and rebuffed her friendly overtures.

There is an interesting account of how the cubs of the fourth litter came to sexual maturity. The female came into oestrus when the cubs were still together. She was courted by and mated with both her brothers but developed a preference for the larger of them. The photographs of courtship and mating are probably unique.

Mrs. Adamson recognises her cheetahs by the individual patterns of markings at the base of the tail. It would have been interesting if she had included the photographs she says she took showing these individual differences. Scientists at the Serengeti Research Institute use patterns of spots on the cheek to recognise individual cheetahs.

The photographs, as usual, are excellent.

R. R.

5. FORESTS OF NEPAL. By J. D. A. Stainton. pp. xvi+181 (14 cm × 7 cm), with 5 maps and 8 charts and 156 coloured illustrations. London, 1972. John Murray. Price £6·50.

For a long time the kingdom of Nepal was closed to travellers, even the Nepalese passed through India to reach the eastern or western districts of their country when official duties compelled them to leave Kathmandu valley. However, conditions have changed since 1950-1951. Earlier, in 1947 and 1948 the Indian Government was permitted to survey the Kosi catchment and some mountaineering expeditions were also allowed in 1949 and 1950.

J. D. A. Stainton was a member of the 1954 expedition to west Nepal which was sponsored jointly by the British Museum (Natural History) and the Royal Horticultural Society. Over the next fifteen years, Adam Stainton made eighteen journeys all over the country, visiting remote regions which are very difficult to access, collecting plants and recording his observations, more widely than any botanist had done so far. The reviewer knows of another—Toni Hagen, a geologist who can claim to have travelled through the country and in all directions over a period of seven years. Adam Stainton, however, continued on his own and makes it clear (p. 2) that he was not connected with the British Museum in any official capacity, although he had been collecting for the herbarium of the Museum on many occasions. It is but natural for one to deposit his specimens in a herbarium, and Adam Stainton has been collecting extensively, an idea of which one can get from the Appendix of his book under review, and also from the fact that a large number of species have been named after him.

The book FORESTS OF NEPAL besides the Introductory remarks and notes on climate, is divided into three parts: I—Geographical divisions of Nepal, II—Forest Types and III—Notes on Distribution. The reviewer finds that in the text, part I is titled as 'Climate and Vegetational Divisions of Nepal' although climate is already dealt with in the earlier pages, and in this part I there is very little about climate.

On page 3, the author is very modest when he says 'being entirely self-taught in matters of botany and ecology, I am well aware that the notes must have many imperfections'. But his treatment on the Forest Types and Notes on Distribution are very analytical, well documented and masterly Adam Stainton mentions of the great variety of climate and vegetation within a small country and in the valley of Kali Gandaki, he has seen abrupt change of climate and vegetation telescoped into a short distance (p. 47). The author has had difficulties to follow Champion's forest types for the classification of forests of East Nepal. In an earlier publication [*Rec. Bot. Surv. Ind.* xix (2), 1965] sudden changes in the vegetation of East Nepal and difficulties to fit in Champion's type in the east have been recorded, and recourse to Gamble's system was taken. Adam Stainton has also divided his Tropical Evergreen Forest by altitude (p. 63), and again depends on altitudinal division for the Temperate Mixed Broadleaved Forests, when he divided them into a Lower which lies between 5-7000 ft. and an upper between 8-10,500 ft. altitude. While the author refers to all the recent publications, he seems to have missed this 1965 publication. In 1966 and 1967 when the reviewer was on collecting tours with Adam Stainton, difficulties to follow Champion's forest types for the classification of forests of East Nepal and the handicaps of Schweinfurth's System were also discussed at length.

In part III—Notes on Distribution, the author rightly says that the species which were previously regarded as East Himalayan or West Himalayan are now known to occur in Nepal. This has been possible only because of the extensive recent collections made by various botanists working on Nepal flora and evidenced by the presence of the specimens in the herbaria or by some publications. The author has indicated the geographical positions of sixteen tree species on maps 2, 3, 4 and 5. On p. 151 the author refers to the presence of *Juglans regia* in Eastern Himalayas as often due to cultivation. The reviewer is tempted to mention that in parts of East Nepal this species occurs at many places and bears no indication whatsoever of having been cultivated, particularly on the slopes of Solu khola and the reserve forest lying to the south of Okhaldunga.

There are a few printing errors, such as on pp. 18 and 175: J. H. Burkhill for I. H. Burkill; p. 82 *Reinwartia* for *Reinwardtia;* pp. 91, 94 and 99: *Sarococcca* for *Sarcococca*, and Sarauja for *Saurauia* or *Saurauja* appear at many places. It is 'bhitri madesh' and not 'bhitri mardesh' as it appears on p. 18.

The book is full of information and is a valuable contribution towards the knowledge of the forests of a country which was till recently botanically unknown. The book should prove extremely useful to all interested in the vegetation of Nepal and will stimulate further interest in the study of the vegetation of Nepal.

The author and the publishers are to be congratulated for the 156 colour photographs most of which assist in the identification of the common shrubs and trees of Nepal.

M. L. BANERJI

6. INDIAN SARDINES (THEIR BIOLOGY AND FISHERY). By R. V. Nair. CSIR Zoological Monograph No. 2. pp. 107 (24·5× 16 cm), with 24 text-figures. New Delhi, 1973. Publications and Information Directorate. Price Rs. 22·00, $7·00, £2·20.

Sardines, one of the most economically important clupeoid fishes, contribute almost a third of the marine fish production in India. It is not, therefore, surprising that many biological investigations have been carried out on these fishes. So far, however, such work was scattered among more than a hundred scientific papers. Moreover, the contradictory views expressed by investigators, especially on raciation and reproductive biology, have created some confusion. The need was, therefore, long felt for bringing together this mass of information into one consolidated compilation. The present monograph does just that.

The format of dealing with the different fishes is fairly uniform. Starting with a brief morphological description and local names of each species, the author goes on to its distribution and seasonal variation (where known). In the section on bionomics, the author has included age and size at maturity, fecundity (where known), spawning season, early life-history, food and feeding habits, size and age composition, and predators and parasites.

Since the oil sardine, *Sardinella longiceps,* is the most economically important as well as the best known, over a third of the book is devoted to it. In addition to the topics mentioned above, the aspects of variability (races), annual variations in catch, legislation, length-weight relationship, shoaling behaviour, and large scale mortality are also included.

The latter part of the book deals with fishery. Since some of the lesser sardines, namely *Sardinella sirm, S. melanura, S. sindensis,* and *S. clupeoides* are not very well known, it is to be expected that their fishery is dealt with cursorily, only one small paragraph being devoted to each of these. However, as the author has thought fit to separate the sections on biology and fishery, it would have been better if the fishery of *Dussumieria hasselti* and of *Kowala coval* had been included in the part on fishery, instead of mixing these up in the biology section. Incidentally, the Marathi name of *Kowala coval* is 'Bhilji', and not 'Bhitgi', as stated on page 74.

While the photographs of fishing are excellent, the same cannot be said about those of fishes, which appear to have lost their quality during printing. It would have been preferable to have line drawings of these fishes instead of photographs, as drawings give a clearer picture of taxonomic characters such as scales, fin-rays, etc. Moreover, photographs of *Sardinella melanura, S. sindensis, S. dayi, S. clupeoides,* and *Dussumieria acuta* have not been given in the book.

Also, although the author has broken up the contents into three main parts; biology of the oil sardine, biology of the lesser sardines, and fishery of the lesser sardines, the reading matter runs continuously from beginning to end of the book, without being separated into different chapters, each to start on a separate page. This makes it confusing to the reader who desires to refer to a subject in the middle of the book, even though bold sub-titles help to some extent.

Apart from these few very minor faults, the book is flawless, having been excellently written and edited. Accurate author, systematic, and subject indices enable the reader to have easy cross reference, while the, by no means small, list of references is valuable for the researcher wishing to refer original papers.

The monograph will be a valuable source book for fishery students as well as research workers.

B. F. C.

Miscellaneous Notes

1. A TRIP TO SILENT VALLEY—MARCH 1972

Mukailly is a small village in the Attapadi or Bhavani River Valley, eighteen miles from Mannarghat, which is a small town on the plains of Kerala below the Western Nilgiris. From Mannarghat, you must ascend the ghat by bus, lorry or jeep, and once over the top of the ghat you are three kilometres from where a forest road meets the main Mannarghat-Coimbatore road at Mukailly at 1200 feet.

It was from Mukailly that David Hayles, an English field naturalist and myself left at 6 a.m. on a fine clear morning in mid-March, our destination a valley, the saddle of which lay twenty miles away and three thousand feet higher. Our purpose was to study insects and snakes and other animals in an area of relatively untouched evergreen rain-forest.

By ten o'clock we had climbed up the side of the Panthan Todu river valley and were traversing a thick piece of savannah in which avenues of crushed grass had been made by the passage of elephants. There we saw barking deer which dashed off through the high elephant grass. After coming out of the grass we sat by a clear, cool bubbling stream on the edge of the forest and ate the brown dough balls we had brought with us from Mukailly. These having filled our stomachs and our feet being cooled off we continued our journey and walked for three miles on the eastern side of the valley. The way was through thick and steep forest and we saw several rat snakes or dhaman, jungle fowl and a barking deer that was moving parallel to us in the forest for about fifty yards affording us a good look, before moving off down to the river. We also saw some leopard spoor showing us that the dinner previously consumed was one of the black monkeys, lion-tailed macaque or the Nilgiri Langur.

We arrived at a parting of paths. We could either go on to Silent Valley, the saddle of which lay some five miles in front, to the north or we could go down to the left (west) and meet the Panthan Todu, a small stream at this elevation—and camp there. We had brought along sleeping bags, 'rawa', sugar and tea for material comforts, and a butterfly net, collecting bottles, snake bags, note books and pencils for the rest.

Being rather weary of foot we opted to go down to the stream and camp there. We walked a mile or so down the path, which leads to a cardamom plantation, crossed the stream and then descended the river bed for a mile and picked a 'safe' place to camp near the edge of the stream under a huge tree. There was ample sign of elephants all around, and having been there before I knew that a herd of eighty or ninety elephants lived in that area plus a couple of solitary tuskers, one relatively docile and the other not so docile. Last year I had met a tribal who collected jak-fruit in the forest who claimed the huge scar across his chest came from this second tusker!

In the afternoon we wandered around, looking at the multitude of birds and insects, also I saw three Nilgiri Langurs taking themselves away, crashing through the tops of trees and later I watched two Malabar Squirrels, one on my left the other on my right, each on different sides of the stream. One called the other which came from my right and crossed the river about fifty feet up by way of branches and joined his companion. Toward evening the bird chorus intensified, southern treepies, racket-tailed drongos and the hill Mynas, the raucous, entertaining relative of the plains myna. We watched the sun sink and the colours change to night, Venus the evening star and the multitudes following shortly after. We made a huge fire, kept it burning all night and slept well into the bargain.

After a breakfast of tea and 'rawa' we went for a look around the locality and found fresh spoor of a solitary elephant fairly near our camp on the stream, also we had the pleasure of watching five Nilgiri Langur feeding in the trees next to the river. We came and went without disturbing them. We paid a visit to the cardamom plantation, after ascending the stream for two miles or so, and in the settlement we heard that the elephants had been around for the last few days and were under that hill in the thick bamboo if we wished to see them.

We spent the day collecting insects and making observations. That night we had a feast of rice and dry fish obtained from the plantation. Another night passed in the same place with an equally large fire. No elephants disturbed our dreams and after breakfast we stashed our sleeping bags in a bush and at six thirty retraced our path up the river, back up the road to the cross roads. We saw in some sand by the stream fairly near our camp fresh sambar, barking deer and leopard tracks.

From the junction of the forest roads it was five miles and a steep climb that took us to the saddle of Silent Valley and the end of the Panthan Todu Valley. On the way to the saddle we saw a lot of Nilgiri Langur and Malabar Squirrels and heard many more hooting, chuckling and crashing in the treetops. Large numbers of grey jungle fowl were scratching and feeding on the leaf covered road and ran away through the forest as we approached.

Whilst walking through this evergreen forest consisting of huge trees with the canopy a hundred feet or more above our heads, we heard that incredible noise, the wing beat of the Great Hornbill. After a few moments a pair flew overhead, crashed into a treetop nearby and in a typical raucous manner fed noisily, crashing about in the branches and dropping fruit on the ground. We left them to their pleasures and continued on our way.

We descended into Silent Valley from the south-eastern side and looking out, could see what a vast area of forest lay before us. We continued for about five miles and stopped and ate some coconut and jaggery for lunch on a stream. This was a tributary of the Kundi Puzha the main river of Silent Valley. We sat by the clear cold tasty water watching butterflies flying up and down the river on their different flight paths. The Red Helen a startling black and white swallowtail and the Blue Mormon, a beautiful iridescent blue and black swallowtail, both some four inches across the wings, using the same flight paths while the white pieridae butterflies always flew straight down the middle of the stream playing follow-the-leader, in lines of twenty or thirty individuals. After spending an hour or two in this place we decided to go and see what lay around the corner and walked on.

After half a mile I thought I heard human voices, so we stopped to listen, and after five minutes heard the noise again, from the thick forest above us, like yet unlike humans. We continued on our way, 'pussyfooting' and after a hundred yards we saw three black monkeys feeding some fifty yards from the path. We were able to see them because of a small nullah running up in that direction. Without a sound we concealed ourselves in the nullah, and after five minutes or so we saw three more monkeys, casually walking a branch from one tree to another some thirty yards away. From their lesser size and the short tail with a knot on the end I knew them to be Lion-tailed Macaques and not Nilgiri Langurs, as we had supposed, and were overjoyed at seeing this rare monkey. (I had only seen it once before in the Singampatti Hills, Tirunelveli Dist., a few weeks previously with Dr. Karr, an American ornithologist.) It soon appeared that there were eleven or twelve adults in this group and unaware of our presence they were feeding all around us. Two of them moved down the nullah, slowly feeding, walking carefully from branch to branch and jumping very little. During half an hour of watching them pluck fruit, eat it, clean themselves, clean the young (two females were with young clinging to their stomachs) we heard them make only three or four quiet vocal sounds. By this time one of the members of the troop was in a tree not ten feet from us and then walked out on the branch across the stream by way of another branch and then into another tree. The first was followed by a second, both monkeys passing not more than five feet from our upturned noses. I clearly recall the face peering down surrounded with white outlined against the afternoon sky and treetops, an unforgettable sight. The two adults stayed in the tree next to us for five minutes before one left and the other one must have seen a movement from us and he gave a low sharp call and moved off quickly, the others who were near us also moved away but after going about fifty yards they stopped and watched us as we left. It is interesting to note how quietly these monkeys move in contrast to the Nilgiri Langur who calls loudly and crashes through the branches, and I wonder if there might be more Lion-tailed Macaques in more places than previously believed, and they have escaped notice, luckily for them, as they sometimes do associate with Nilgiri Langurs and most people would naturally pass them off as being black langurs. Also at the end of March a sighting of Lion-tailed Macaques was made in Shimoga Dist. at two thousand feet in evergreen forest by Romulus Whitaker. For two years, I believe, there have been no official sightings and now we have three sightings in three places hundreds of miles apart all in the same type of forest within a month.

After seeing the Lion-tailed Macaques, David and I returned to our camp in a very elevated mood. We brewed a cup of tea, sat down and had a smoke before gathering wood and settling down for the night. The next morning we were to try to descend the Panthan Todu river to the Bhavani River—impossible as far as local people were concerned.

We left our camp at six in the morning after tea and a smile. The river bed ran fairly flatly for the first eight miles through thick evergreen jungle. We followed the river and where that was impossible we went by elephant trails. We found the skeleton, complete with horns of a large Sambar lying by the edge of the water. The horns were very fine and David tried cutting them off with his machete. He eventually threw the blunted implement away.

It took a long time to traverse the next five miles due to deep pools and steep sides around which we had to climb. Mostly we were able to follow a recent elephant path, the newest amongst the many old ones trampled through the undergrowth. We left the river following this trail cutting off, a bend as we thought, and found ourselves descending into one of those three sided nullahs, full of bamboo, still, quiet and hot under the midday sun. As we reached the flat bottom of the nullah we saw fresh elephant spoor of that morning. From the vibration of the place and the silence it seemed evident to me that one of the solitary tuskers was there, well aware of us no doubt, and not making a sound. We retreated quietly back to the river and then continued downstream. We eventually reached a place where the river descended over the edge of the upper part of the valley for five hundred feet or so in a series of spectacular waterfalls. In the lower part of the valleys we could see the usual signs of civilization, dirt tracks, fires burning, forest burning, ground cleared and left to waste, and tribal huts. It seemed very dry and hot down there after the lush greenery we had been travelling through.

We managed to descend these waterfalls by going round to the left of the river and descending down the steep granite slopes and by following an old elephant trail, it's really amazing the gradients that an elephant can negotiate. I could just picture a number of them, crossing this area, by the light of the moon, on their way to the Attapadi valley.

After a swim in the pool at the bottom of the last falls and a rest and smoke, the time being about four o'clock and us being hungry, we walked on quickly the last four miles to Mukailly, picked up our luggage, filled our stomachs, and set out for Shimoga Dist. where we were to meet our associate and friend Romulus Whitaker in search of king cobras.

LONGTHORNS,
BLANDFORD,
DORSET, ENGLAND,
July 18, 1972.

CHRISTOPHER PRUETT

2. THE KANJIRANKULAM BREEDING BIRD SANCTUARY IN THE RAMNAD DISTRICT OF TAMIL NADU

Ramnad District has a rich and varied avifauna, particularly the eastern part of the district with its numerous lakes, ponds and tanks. To mention a few; near Manamadurai is the 'Pasalai Kanmai' (Kanmai = big lake) now divided into two by the Manamadurai-Aruppukottai railway line. Ramnad town has two lakes nearby, the Chakkarakottai Kanmai, where Flamingos can be seen in March, and Periakanmai which looks like an inland sea. These two lakes alone can offer considerable material for a study of the avifauna. This part of District does not have any hills, or forest; but a good portion of it is covered with scrub jungle with its peculiar fauna.

In this paper a brief account is given of a Bird Sanctuary situated in a small hamlet called Kanjirankulam which is about 4 km from Mudukulathur in Ramnad District of Tamil Nadu. It can be reached either by rail and road from Madurai through Paramakudy and Mudukulathur or by road through Aruppukottai, Kamuthi and Mudukulathur. The distance by either route may be about 70 miles. There is no place to stay in the hamlet. There is however an Elementary School, whose teachers offer assistance to visitors.

The history of this little known sanctuary is interesting. About 25 years ago Pelicans and Painted Storks began to be seen in some coastal villages like Cheluvanoor, Komboothi, Pillayarkulam and also at Chitrankudi and Kanjirankulam. The latter two villages are away from the sea but have tanks. Now the birds have disappeared from all the other villages except Kanjirankulam where they were left unmolested by villagers, otherwise the colony would have been decimated long ago. This nesting area was not established by any statute of the State, nor by any Government Department but by the common consent of the villagers of Kanjirankulam. They guard the colony zealously and trespassers are summarily dealt with.

The nesting colony is of about sixty trees. The important species being *Ficus religiosa*, *Thespesia populnea* and *Acacia arabica*. The trees stand on the tank bund and also in the tank bed; the latter are surrounded by water in the rainy season. The ubiquitous *Prosopis juliflora* is found in abundance making it impossible for the observer to move about. In the biggest banyan trees many nests of pelicans with the young ones can be seen. Many trees have been denuded of slender branches probably by the birds of the colony for use in their nests.

There is constant traffic of birds in the Kanjirankulam area. Some birds arrive at the colony with material for building nests, others may arrive after foraging, with food for their young ones. What may look like a speck on the horizon may land on the trees as a pelican. The birds go out and return singly or in parties.

The nesting species of the colony are Spotbilled or Brown Pelican, *Pelecanus philippensis* and Painted Stork *Ibis leucocephalus.* Besides these one can see the White Ibis, *Threskiornis melanocephalus* and the Black Ibis, *Pseudibis papillosa.* These birds nest in trees a mile away from Kanjirankulam. Even from a distance of about two furlongs one can hear the din made by the inhabitants of the colony. Every tree in the sanctuary sags under the weight of a number of nests, holding eggs and growing young chicks. One of the banyan trees has numerous of nests, of pelicans and painted storks. Every branch at different heights presents some tens of nests.

In the same tree on adjacent boughs one can see nests of both species. During my visits I did not see any fight between the birds over territorial rights but pilferage of nesting material occurred with only mild protests by the loser. Every member of the colony was found busy bringing nesting materials or feeding the young ones. This consociation of painted stork and pelicans was also recorded in a valley east of Cuddapah District at the close of the last century by Rev. Howard Campbell. This pelican-painted stork association exists in the small colony of birds at Moontudaippoo near Palayamkottai; and also in Kundakulam in Nangunery Taluk in Tirunelveli District. The pelicans' sociability is shown in their nesting and foraging habits.

Clumsy as the pelican looks, it can soar high ; and this can be observed near the colony. It shares this habit with the vultures and the storks.

In this dry zone area the pelican is distributed wherever suitable sheets of water such as large lakes, tanks and coastal lagoons exist. It is common nearer the sea than inland. I have seen pelicans in a lake in Chingleput district fishing in company in a horseshoe formation into which the fish may be driven into a mass so that the participants can take their fill. Pelicans take considerable quantities of fish especially when feeding young and the lessees to whom the fishing rights are sold by Government scare away these birds by shooting them or by explosives, lest these birds come and fish heavily thus depriving the lessees of a good portion of their profit. But at Kanjirankulam such acts are not allowed by the inhabitants of the hamlet.

The Painted Storks are also as numerous as the pelicans in the Sanctuary.

The villagers assure me that the parent birds stand on eastern side of the nest in the forenoon and on western side of the nest in the afternoon to protect their young ones from the sun. This has to be verified during my next visit to the Sanctuary. However, even the casual visitor cannot but notice the way the Painted Stork protects the young ones from the sun by spreading its broad and long wings over the young ones as a sort of improvised roof.

It is believed that the Painted Stork lays 3-5 eggs. But according to Blandford usually 4 eggs but sometimes as many as 8 eggs are laid. However, as I went about counting the young ones in the various nests there were never more than 4 young chicks. I have watched the young ones clambering among the thorny materials around the nest and among the thorny branches of the acacia trees without being hurt by the thorns. When I visited the Sanctuary last in the fag end of April the water in the neighbouring tanks had dried up and no evidence of existence of water in the neighbourhood could be seen. I was told by the villagers that as there was no source of water within a radius of 10 miles the birds must go to sea coast for their food. This has to be verified. I have been informed that even in hottest period of summer some birds stay in the Sanctuary.

Unlike the villagers of Kundukulam in Nangunery of Tirunelveli District, who propose to destroy the pelican colony because of the noise and bad odour produced by the pelicans and Painted Storks, the villagers in the Kanjirankulam very zealously guard the colony, even to the extent of caring for the young which fall from their nest due to wind or some other cause. The villagers feed these forlorn young with a meal of fish, frogs and snakes which are chopped up for the purpose. I have been told that even the village dogs do not molest these hapless young chicks which slowly grow and finally join their tribe and fly away. The villagers make use of the guano to manure their land. Each villager collects it by turn. The yield of crops is said to double in quantity on the application of the guano.

If the State Government can declare an area within a radius of 10 miles around Kanjirankulam as a 'protected region' where shooting is prohibited, it will be rendering a great service to the birds. Secondly, to make up the deficiency of nesting material for the birds, the Forest Department may consider planting more *Acacia* trees or *Thespesia* trees in and around the sanctuary. I heard that in some of the tanks in other parts of Ramnad District such a scheme is implemented.

Lastly if it is possible, the Government can let some water into the nearest tank during summer so that the birds need not fly about 14 miles each way for water (as the villagers allege).

ACKNOWLEDGEMENTS

I thank Prof. S. Krishnaswamy, Ph.D., D.Sc., Head of the Department of Biological Sciences, Madurai University, for providing me all the facilities for this work. This work was carried out during the tenure of

a U.G.C. Fellowship. I am thankful to the villagers of Kanjirankulam for giving me information in response to my queries.

DEPT. OF BIOLOGICAL SCIENCES,
MADURAI UNIVERSITY,
MADURAI-21,
September 22, 1972.

S. ABRAHAM

3. INTERESTING DISTRIBUTIONAL RECORDS FOR PAKISTAN

It has long been recognised that the outer foothills of north-eastern Pakistan abutting on the Punjab plain represent the westernmost range extension of many interesting endemic Indo-Malaysian plant species characteristic of tropical dry-deciduous forest with a richness of variety quite lacking in any other part of Pakistan (McVean 1962). The Murree foothills, Kahuta and Margalla hills have vegetation typical of this narrow zone (Stewart 1958).

Not unnaturally there are a few mammals and many bird species characteristic of the oriental faunal zone, which enter Pakistan in this region only. Apart from the resident species, many of which are in themselves unique and interesting, there are always occasional or regular avian wanderers which invade westwards from the Siwaliks. I have passed many hundreds of hours of pleasurable bird watching in these hills with always the excitement of seeing a potential rarity and after one such recent visit to the region in early January 1973, feel that it would be useful to record the more interesting records, which are at variance with known distribution as published in S. Dillon Ripley's SYNOPSIS (1961).

557. **Blossomheaded Parakeet** *Psittacula cyanocephala.* In his account of the birds of Rawalpindi district, Whistler (1938) describes it as an irregularly occurring visitor to the northern Punjab and Salt Range mostly in winter. Having encountered it in April and May in the Murree foothills I had long suspected that a few might stay to breed. On June 6th 1972 I found two occupied nestholes of these parrots in a dead pine tree in the Lehtrar valley at about 4000 feet. The young birds were visible coming to the mouth of the nestholes when the parents arrived with food.

788. **Bluethroated Barbet** *Megalaima asiatica.* Not specifically included within Pakistan territory in the SYNOPSIS. This Barbet was nevertheless recorded by Hugh Whistler (1938)—as

an occasional sighting and appears to have increased since it is now a resident species in the Murree foothills whose ringing call in summer is a familiar sound.

1335. **Redbilled Leiothrix** *Leiothrix lutea*. December 23rd 1968 an adult male seen at Lehtrar at about 2500 ft. It was extremely tame and allowed approach to within a few feet and was watched for about one hour by myself and two companions. The late H. W. Waite (1926) also secured a specimen from the Margalla Hills in December which is now in the B.M. (N.H.) Collection.

1892. **Thickbilled Flowerpecker** *Dicaeum agile*. 5 Specimens collected September 1967 at Marala on the Chenab River at 800 feet. A group of four seen feeding June 6th 1972 in the Margalla Hills at 2500 feet.

1919. **Mrs. Gould's Sunbird** *Aethopyga gouldiae*. Two adult males observed from December 30th 1972 to January 1st 1973 at Nurpur Shahan, Margalla Hills at about 1600 feet. These birds were regularly seen around the vicinity of a grove of trees and Shrine for three successive days, feeding on the nectar of the plant parasite *Loranthus longiflorus* which was at that time in flower.

1973. **Spotted Munia** *Lonchura punctulata*. It is surprising that this species was not recorded by Hugh Whistler from Rawalpindi district in the Murree Hills as it is a fairly common resident in the outer foothills extending westwards to Swat. In 1965 I found a nest presumed to be of this species at Gora Gali at 4500 feet in the Murree Hills. I have sight records in the Margalla Hills in late December, mid September and late July.

2017. **Pinkbrowed Rosefinch** *Carpodacus rhodochrous*. In late winter and early spring this beautiful little finch can invariably be found in some of the more secluded ravines in Margalla Hills and it is therefore more than a straggler as described in Ripley's SYNOPSIS.

There are two negative observations which might also be made with reference to this region of Pakistan and the SYNOPSIS.

1657. **Golden Bush Robin** *Erithacus chrysaeus*. The SYNOPSIS states that it occurs in Hazara and the border of Murree. To the best of my knowledge this is based on a single record of a nest taken by Colonel Rattray near Changla Gali in 1904. Many of Colonel Rattray's records have subsequently proved to be unreliable especially covering the genus *Phylloscopus*. He collected eggs mostly using native collectors. There are no subsequent published records and it was not observed by Whistler or Waite in the region.

1733. **Orangeheaded Ground Thrush** *Zoothera citrina*. In the SYNOPSIS it is stated that this species breeds in West Pakistan from Murree eastwards. I have in former years often seen it in the Chittagong Hills of Bangladesh and I am positive it does not occur anywhere in the Murree foothills having never encountered it in periodic residence and visits dating from about 1952. Neither Waite nor Whistler observed this species and both knew the region well.

Roberts Cotton Associates Ltd.,
Khanewal, TOM ROBERTS
Pakistan,
January 29, 1973

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4. THE INDIAN LORIKEET (*LORICULUS VERNALIS*): ITS COURTSHIP AND MATING

On 23-xi-1972 I observed a pair of Indian Lorikeets courting and mating. As what I saw differed from G. M. Henry's (1955) account of the courtship of the Ceylon Lorikeet (*Loriculus beryllinus*) to which the HANDBOOK OF THE BIRDS OF INDIA & PAKISTAN (1969) makes a reference, and as F. G. Buckley (1968) states that 'Information on copulation in *Loriculus* spp. (how, when or if it is done while hanging or upright) is not at present available in the literature', even this isolated, chance observation of mine may have some value.

On 23-xi-1972, while watching a party of four Fairy Bluebirds (*Irene puella*) in the Kallar Reserved Forest (altitude 640 m, Ponmudi Hills, *c*. 56 km north-east of Trivandrum) something green and red moving on a branch of the thinly foliaged tree caught my eye. It was a Lorikeet which had just extended its neck and gently pecked at another Lorikeet sitting a few inches away on the same branch. The first bird (which later mounted the other and is, therefore, referred to as the male hereafter) was evidently highly excited whereas the other appeared to be rather indifferent and inert. The male shot out his head and as soon as he had touched the bill of the female, smartly retracted his head. To this the female responded by slowly extending her neck and touching the male's bill. As soon as she had withdrawn her head, the male again smartly thrust his head forward, touched her bill, and swiftly pulled his head back. The female again responded, but her movements were consistently much slower. After repeating this half a dozen times, the male sidled up to the female and they sat shoulder to shoulder, almost pressed against each other for a short while, perched across the branch. Then the male suddenly leaped over the female's back, sat for a few moments on the other side, and then leaped back to his former position. This too was repeated a number of times.

The male then attempted to mount on the other's back. Three times he failed to gain a hold but at the fourth attempt he managed to effect coitus. Unfortunately, I was unable to see whether he took hold of the female's neck or back feathers to maintain himself on her back. As soon as the mating was over, they settled down again shoulder to shoulder on the branch. The female had never moved from her original perch throughout this period.

I jotted down notes as quickly as I could and again directed the binoculars at the branch. But the birds had disappeared. They must have flown off without uttering their usual squeaky calls. All the time I was observing them, the birds uttered no note that was audible to me at a distance of some 40 feet.

Throughout, the male kept his scarlet rump (and upper tail-covert ?) feathers erect. They stood out like a long scarlet mound between the wings which, however, seemed to be kept close to the body. The female erected her rump feathers only just before the male started vaulting over her back; and the feathers did not stand out as prominently as did those of the male.

The three-inch-thick horizontal branch on which the Lorikeets were was about 25 feet above the base of the tree and had many leafy branches above and below it. As the tree stood on the lower slope of the hill, I was almost at the same level as the birds.

The whole incident took only five minutes (16.15 to 16.20 hrs.). Visibility was quite good. Throughout the birds were in an upright position, perching across the branch like ordinary passerines.

It is not quite improbable that some other components of courtship display (such as the 'strutting' described by Henry in *L. beryllinus* and by Buckley in *L. galgulus*) had preceded the display observed by me, though one would expect such manifestations of mounting excitement (no pun intended !) to occur just before copulation. Still, in the incident reported above, the two birds sat quietly shoulder to shoulder for a few moments just before the male began leaping over the female.

I do not think that during the period when the birds were under observation the male fed the female ; nor did he hold his body erect or fluff out his throat feathers. For most of the time the male held his body in a horizontal position.

I am very grateful to Sri S. Parameswara Iyer, District Forest Officer, Trivandrum, and Sri R. Parameswaran, Professor of Zoology, College for Women, Trivandrum, but for whose kindness I would not have been at Kallar on that day.

UNIVERSITY COLLEGE,
TRIVANDRUM,
April 14, 1973.

K. K. NEELAKANTAN

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5. OCCURRENCE OF THE STARLING, *STURNUS VULGARIS* LINNAEUS NEAR BANGALORE

According to the INDIAN HANDBOOK (Ali & Ripley 1972), the Starling, *Sturnus vulgaris* Linnaeus is not known to winter in southern India, only a few stragglers having been taken from Madras, Bombay and near Minicoy Island. Whistler & Kinnear (1934) opined that the starling was evidently only a winter straggler to the erstwhile Madras Presidency and Phillips (1963) reported a sight record of a single starling at sea, about 40 miles west of Minicoy Island on December 10, 1954. Abdulali (1965) collected three specimens out of a flock of about a dozen starlings at Rewas in Alibag taluk (Kolaba district, Maharashtra) and put them down as *S.v. poltaratskyi* Finsch. Ali & Ripley (1972) state that this subspecies is an abundant winter visitor to southern Pakistan and continental India south to Gujarat, Madhya Pradesh and Bihar. Besides the abovementioned records of stragglers, the starling is not known to winter in southern India.

On October 24, 1965, while out birding some 7-8 miles north-east of Bangalore, I saw a huge flock of about 300-350 myna-like birds in a harvested field adjoining an extensive patch of short open scrub. One specimen was shot out of this flock and later identified as *S. vulgaris*, most probably of the race *poltaratskyi*. The remarkable thing about this record is the large number seen as opposed to single or at the most 12 birds recorded previously as stragglers.

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Bangalore-560024,
December 21, 1972.

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6. TREE SPARROW *PASSER MONTANUS* (L.) IN THE EASTERN GHATS

During the banding session of the B.N.H.S. bird migration study project at Lammasinghi in the Visakhapatnam section of the Eastern Ghats in April-May year 1972, we obtained a few specimens of the Tree Sparrow *Passer montanus* (Linn.).

This is an interesting record as the distribution of the species according to the SYNOPSIS and FAUNA is northern parts of India along the Himalayan ranges east to Nepal, Tibet, Bhutan and south to Assam and Manipur etc.

The present record is the first from the E. ghats and adds northern Andhra to its known range.

The population of tree sparrows at Lammasinghi is more or less localised and the male specimen we preserved for record was in breeding condition as evinced by the enlarged gonads. Two species of sparrows (*Passer domesticus* and *P. montanus*) co-exist at Lammasinghi and it is desirable to study their ecology.

ALAMANDA (R.S.),
VISAKHAPATNAM DIST.,
ANDHRA PRADESH.

K. S. R. KRISHNA RAJU

FERNHILL COTTAGE,
CAMBERLEY,
ENGLAND,
April 27, 1973.

TREVOR D. PRICE

7. FOOD AND FEEDING HABITS OF THE TOAD, *BUFO MELANOSTICTUS* SCHNEIDER (AMPHIBIA : BUFONIDAE)

In India practically no attempt has been made to study the feeding habits of the common toads, excepting for a stray record of Rai *et al.* (1969) of the adults of the white grub, *Holotrichia consanguinea* Blanch. being fed upon by the common Indian toad, *Bufo melanostictus*. Prasad (1961), while reviewing the natural enemies of the sugarcane white grubs, indicated the beneficial effect of introduction of the Surinam toad, *Bufo marinus*, into Puerto Rico and Hawaii in the control of scarabaeids.

The present study involed examination of the stomach contents of 362 individuals of the common Indian toad, *Bufo melanostictus* Schneider carried over a period of 14 months during 1968-1970. The toads were collected during the evenings almost every fortnight during the period in various agricultural fields and near lamp posts around Dharwar, Mysore State. The toads thus collected the previous evening were sexed and dissected, the stomachs were cut out and preserved separately in 10 per cent formaldehyde for future examination of the contents. The stomachs thus preserved were slit open, the contents were taken out and identified taking care to see that the number of individual insects and other animals was correctly recorded. The data are summarised groupwise in Table 1.

RESULTS AND DISCUSSION

Toads in general are well known to feed on different groups of animals of which insects constitute the major bulk. In the present study also insects were recovered from stomachs and constituted 99 per cent of the total number of various animals consumed. Two other

TABLE 1

ANALYSIS OF THE STOMACH CONTENTS OF *Bufo melanostictus*

Animal group	No. of stomachs containing the animals	Per cent	No. of individuals	Per cent	Remarks
I. INSECTA					
1. Order Coleoptera					
Family Carabidae ..	58		106		
,, Chrysomelidae ..	11		14		
,, Cicindelidae ..	3		5		
,, Curculionidae ..	17		18		
,, Coccinellidae ..	2		2		
,, Elateridae ..	13		33		
,, Scarabaeidae ..	79		196		
,, Tenebrionidae ..	82		345		
,, Others (including grubs and pupae)	19		38		
	284	78	757	26	
2. Order Hymenoptera					
Family Apidae ..	3		11		
,, Formicidae ..	137		1293		
,, Vespidae ..	6		19		
,, Others ..	3		3		
	149	41	1326	46	

TABLE 1—(*Continued*)

Animal group	No. of stomachs containing the animals	Per cent	No. of individuals	Per cent	Remarks
3. Order Diptera					
Family Syrphidae ..	21		93		
,, Muscidae ..	3		4		
Others (including maggots, Pupae and eggs) ..	16		216		207 maggots were recovered from 12 stomachs.
	40	11	313	11	
4. Order Lepidoptera					
Hairy caterpillars ..	7		19		
Other caterpillars ..	17		62		
	24	7	81	3	
5. Order Dictyoptera					
Family Blattidae ..	52		74		43 of these were *Periplaneta americana*.
,, Mantidae ..	1		1		
	53	15	75		3
6. Order Orthoptera					
Family Acrididae ..	3		3		
,, Gryllidae ..	10		13		
,, Gryllotalpidae ..	22		45		
	35	10	61	2	

7. Order Dermaptera ..	46	13	105	4	
8. Order Heteroptera					
Family Lygaeidae ..	8		55		Mostly *Nezara viridula*
,, Pentatomidae ..	26		46		
,, Reduviidae ..	3		3		
Others ..	5		7		
	42	12	111	4	
9. Order Homoptera					
Family Cicadellidae ..	1		1		
,, Membracidae ..	1		1		
	2		2	Less than 1	
II. ARACHNIDA					
10. Order Araneae (Spiders) ..	5		9		
11. Order (Scorpionida (Scorpions) ..	1		1		
	6		10	Less than 1	
III. MYRIAPODA					
12. Order Scolopendromorpha (Centipedes)	2		3		Mostly *Streptogonopus jerdoni* (Pocock).
13. Order Polydesmida (Millipedes) ..	4		11		
	6		14	Less than 1	
IV. GASTROPODA					
14. Order Euthyneura (Snails) ..	2		10		
-do- (Slugs) ..	3		5		
	5		15	Less than 1	

TABLE 1—(*Continued*)

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,, Membracidae ..	1		1		
	2		2	Less than 1	
II. ARACHNIDA					
10. Order Araneae (Spiders) ..	5		9		
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IV. GASTROPODA					
14. Order Euthyneura (Snails) ..	2		10		
-do- (Slugs) ..	3		5		
	5		15	Less than 1	

groups of arthropods, namely Arachnida and Myriapoda, were also represented in the stomach contents but formed only less than one per cent. Snails and slugs were also noticed to be consumed by the toad to a negligible extent.

Of 362 toads examined, the largest number, namely 284 stomachs contained insects belonging to Coleoptera, and the next was Hymenoptera which were recovered in 149 stomachs. But, in the percentage of individuals of different groups consumed, the Hymenoptera tops the list contributing 46 per cent of the total number of insects consumed, whereas the Coleoptera accounts for only 26 per cent.

The table indicates clearly that excepting for a few coccinellids and cicindellids which may be considered as beneficial, most of the other beetles recovered from the stomachs are either Phytophagous or saprophytic. The curculionids, chrysomelids and cerambycids which are all phytophagous constitute less than 5 per cent of the beetle diet of the toad. The other beetle groups, like Elateridae, Tenebrionidae found in the stomachs also have plant feeding species. The toad appears to be fond of tenebrionids which constitute nearly 50 per cent of beetles consumed. The scarabaeids, several of which are phytophagous account for 23 per cent and the Carabids for 16 per cent. The total beetle diet in relation to other insects recorded during the present study agrees very well with the finding of Kirkland (1897) who reported that beetles constituted 27 per cent of the insect diet of *Bufo lentiginosus americanus* (LeC.)

As stated by Garman (1901) and Kirkland (1897) the present study also revealed that this toad fed to a large extent on ants which constitute nearly 46 per cent of the insect diet. Of the Diptera (which forms 11 per cent of the insect diet) it is interesting to note that 66 per cent of these were in the form of maggots, which are generally not active movers. The order Lepidoptera was represented to the extent of 3 per cent in the stomachs dissected in the form of larval stage only of which nearly 30 per cent was in the form of hairy caterpillars alone. This is not in conformity with the findings of Kirkland (1897) who reported that Lepidoptera constituted 28 per cent of the diet of the toad, *Bufo lentiginosus americanus*. It is significant to note that 3 per cent of the insect diet of the toad consisted of the cockroaches and most of these were *Periplaneta americana*. This finding supports the suggestion of Sweetman (1936) that the toads could be usefully employed for the control of cockroaches in dwelling houses. It is also interesting that the plant feeding bugs constituted about 4 per cent of the food of the toad and only a very few predaceous bugs were noted in the stomach contents.

On the whole, it may be stated that the present study on the food of the common Indian toad, *Bufo melanostictus*, has revealed that the toad feeds mostly on insects and most of these insects do not belong to the beneficial groups. Thus the species may be considered as a useful amphibian which may be encouraged in gardens and orchards that afford cool and moist environment congenial for the life of this toad.

ACKNOWLEDGEMENTS

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8. BIOMETRIC STUDIES ON *THERAPON JARBUA* (BLOCH)[1]

(*With a text-figure*)

INTRODUCTION

T. jarbua occurs in brackish waters and in the sea off Madras throughout the year. At Porto Novo (11° 29′N 79° 49′E) and also in the Vellar estuary, this species occurs at all times of the year, but larger specimens of the size 12·0-14·6 cm were obtained from the sea. This note deals with certain biometric characters of the perch *Therapon jarbua* of the Porto Novo area.

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[1] This study formed a part of the dissertation submitted in partial fulfilment of the requirements for the degree of M.Sc., from the Annamalai University, 1969.

MATERIAL AND METHODS

Random samples were collected from the catches landed by gill nets, drift nets and cast nets. The collections were made between first week of July and end of December, during which period, *T. jarbua* is landed abundantly. The data on the morphometric characters were subjected to statistical analysis to estimate the population parameters. A total of 92 specimens belonging to different size classes, were used for this study. All the fishes were measured, in fresh condition, for standard length, total length, fork length, head length, pre-orbital length, post-orbital length, pectoral fin length, pelvic fin length, depth occiput, depth at dorsal origin, depth at anal origin, snout to the pelvic origin, snout to the anal origin, first dorsal lobe and second dorsal lobe. Standard length of the fish was used as a basic character, against which regression curves, for other variables were drawn. The data is arranged according to numerical values and separated into 10 classes of 0·9 cm interval.

With a view to finding out the relationship between the various parameters and standard length, the general equation $y = a + bx$ was employed. The 'a' and 'b' values for each parameter are given in the Table 1.

TABLE 1

REGRESSION COEFFICIENT, 'A' AND 'B' VALUES AND THE ANGLE OF THE TANGENT FOR DIFFERENT BODY REGIONS

Sl. No.	Parameters	'A' value	'B' value	Angle of the Tangent value		Allometry
1.	Eye diameter	0·184	0·067	3°	50′	—
2.	Snout length	0·147	0·083	4°	45′	—
3.	Post orbital	0·227	0·155	8°	49′	—
4.	Pectoral fin	0·181	0·160	9°	6′	—
5.	Depth occiput	0·355	0·174	9°	52′	—
6.	II Dorsal lobe	0·021	0·188	10°	39′	—
7.	Pelvic fin	—0·052	0·215	12°	8′	—
8.	Depth anal	0·091	0·273	15°	16′	—
9.	Head length	0·472	0·289	16°	8′	—
10.	Depth dorsal	0·199	0·321	17°	48′	—
11.	I dorsal lobe	—0·085	0·330	18°	16′	—
12.	Snout to pelvic	0·495	0·340	18°	47′	—
13.	Snout to I dorsal	0·262	0·379	20°	45′	—
14.	Snout to anal	0·146	0·662	33°	31′	—
15.	Snout to II dorsal	0·250	0·668	33°	45′	—
16.	Snout to fork	0·268	1·129	48°	29′	+
17.	Total length	0·160	1·227	50°	49′	+

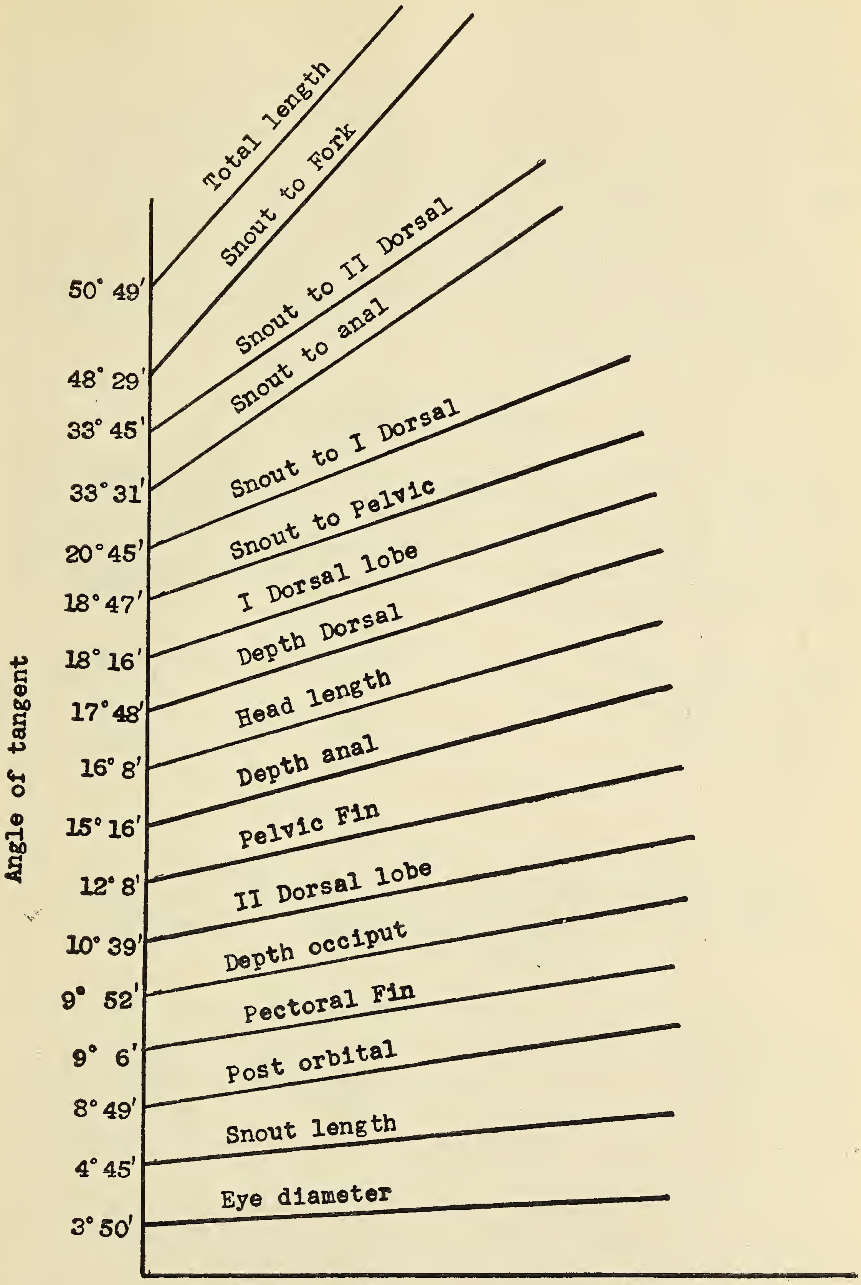

Fig. 1.

Allometry

GROWTH RATE OF VARIOUS PARAMETERS

RESULTS AND DISCUSSION

The data analysed are presented in table 1. The regression lines based on the angle of the tangent are presented in Fig. 1, where the growth rate of various parameters are shown. The regression lines reveal that the total length has the fastest growth followed by the fork length. Snout to second dorsal grows faster than the snout to anal. A comparison of the relative growth of the fins shows that the first dorsal lobe grows faster than the pelvic fin, second dorsal lobe and pectoral fin.

The rate of growth of head length falls between depth dorsal and depth anal. Eye diameter recorded the slowest rate of growth, the second least being the snout length.

ACKNOWLEDGEMENTS

I am greatly indebted to Professor R. V. Seshaiya (Retired Director, C.A.S. in Marine Biology, Annamalai University, Porto Novo) for facilities and advice and to Dr. M. S. Prabhu, Scientist, National Institute of Oceanography, Panjim, Goa, for going through the manuscript and offering helpful suggestions.

DEPT. OF ZOOLOGY,
THE NEW COLLEGE,
MADRAS-600 014,
April 27, 1973.

A. RAHIM

9. ON THE OCCURRENCE OF A RECORD SHOAL OF RED SNAPPER *LUTIANUS ARGENTIMACULATUS* FORSKAL OFF COCHIN

Landings of perches are common along the east coast of India eventhough they appear sporadically along the west coast. However, it is of interest to record a shoal of 170 Red Snapper *Lutianus argentimaculatus* Forskal weighing 1141 Kg which were caught off Cochin by the vessel 'Blue Fin 93', training-cum-fishing vessel of the Central Institute of Fisheries Operatives, Cochin.

The fishes were caught by the vessel on 31st January 1972 when she was on her 142nd voyage at a depth of 25 m between 0830 and 1015 hrs in a single haul. The weight of the specimens ranged between 7 to 10 Kg and were 51 to 63·5 cm in length. The most interesting feature which needs special mention is that eventhough the vessel operated the same gear (450 meshes Trawl-Garfil) in the same ground and at the same depth and made five hauls, not a single specimen was caught in the other four hauls. The skipper of the vessel confirmed that this is the first time that such a shoal of Red Snapper was caught by the vessel. There seems to be no record of occurrence of such large shoals of this particular species around Cochin waters.

The sea bottom at the fishing grounds was predominantly muddy with plenty of shells. Other varieties of fishes which were found with the catch were Sharks, Skates and Rays (20 Kg), white fish (2 Kg), small carangids (3 Kg), small jew fishes (3 Kg), flat fishes (5 Kg), Barracuda (3 Kg), Cat fishes (100 Kg) and Sand lobsters (3 Kg).

The catch/hr for Red Snapper, at this ground worked out for this particular haul to 652 Kg/hr.

ACKNOWLEDGEMENTS

Thanks are due to Shri M. C. Perumal, Director, Central Institute of Fisheries Operatives, Cochin, for his encouragement and permission to publish this note. Thanks are also due to Shri K. Balan, Skipper and crew of the vessel for the keen interest shown for recording the details of operation.

CENTRAL INSTITUTE OF FISHERIES OPERATIVES,
COCHIN-16,
June 2, 1972.

V. NARAYANA PILLAI
V. S. RAMACHANDRAN

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10. A PARTIAL AMBICOLORATION IN THE INDIAN HALIBUT *PSETTODES ERUMEI* (BLOCH) (PSETTODIDAE : PLEURONECTIFORMES) FROM PORTO NOVO, S. INDIA

(*With a text-figure*)

Ambicoloration or pigmentation on the blind side of the flat fishes is said to be associated with the tendency to regain bilateral symmetry (Norman 1934)[1].

On 19th February, 1971, an ambicolorate specimen (Fig. 1) of the Indian halibut *Psettodes erumei* (Bloch) (Psettodidae) was caught in a commercial catch of 17 normal specimens of the same species was made at Porto Novo. This is the first time that an ambicolorate specimen has been collected from this area. The specimen measuring 312 mm in total length, is normal on its ocular side. On the blind side, however, one-third of the body towards the anterior side shows a white patch towards the dorsal fin. The pigmentation extends posteriorly from the pelvic fin ending along the 30th ray of the dorsal fin in a diagonal manner. Excepting for the coloration the fish was normal in all other respects.

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[1] Norman, J. R. (1934) : A systematic monograph of the flat fishes. (Heterostomata) I. pp. 22-27. London.

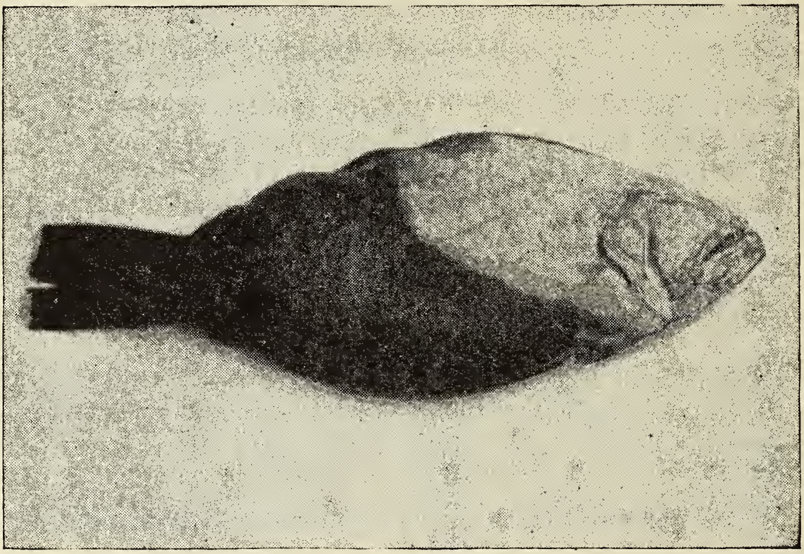

Fig. 1. *Psettodes erumei* (Bloch). View of ambicolorate specimen from blind side.

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to Dr. R. Natarajan, Director, Centre of Advanced Study in Marine Biology, Porto Novo for facilities. Thanks are also due to Mr. Antony Fernando and Mr. Joel for help with literature. The award of a Junior Research Fellowship by the U.G.C. is gratefully acknowledged.

CENTRE OF ADVANCED STUDY IN
MARINE BIOLOGY,
PORTO NOVO, TAMILNADU,
March 20, 1971.

V. RAMAIYAN

11. AN ARTIFICIAL DIET FOR THE REARING OF ACARID MITE

Some acarid mites are well known as important pests of stored agricultural products. While studying the biology of some acarid mites, difficulty was experienced in finding a suitable medium for rearing them on a large scale for experimental purposes. The assessment of the nutritional requirements of the mites would also be simplified if a suitable diet was available.

Preliminary studies were made by Kanungo & Behura (1958) on the effect of synthetic food on *Caloglyphus* sp. Recently two species of acarid mites were reared on an artificial diet by Bot & Meyer (1967). Another artificial medium, originally developed by Mykola H. Haydak (1936) for rearing of some laboratory insects, was also found highly suitable for rearing of *Tyrophagus* sp. by us.

The composition of the diet is as follows :

I.	Corn flour	.. 4 parts by weight
	Whole wheat flour	.. 2 parts by weight
	Skim milk powder	.. 2 parts by weight
	Dried powder yeast	.. 1 part by weight
	Wheat bran	.. 2 parts by weight

These ingredients are mixed thoroughly.

II. Equal parts of honey and glycerine are mixed by volume.

Then equal parts of I and II are mixed by weight and the mixture is allowed to stand for about 24 hours for penetration of the liquid into the dry components of the food.

The diet infested with insects and kept for more than one month, was found to be better than the freshly prepared one for the mite growth probably due to the fungal growth in the diet. The mites reared on this diet were found to complete their life-cycle within 8-11 days at 25 ± 1°C and 80% R.H. and their multiplication was very rapid under these conditions.

ACKNOWLEDGEMENT

We are grateful to Dr. N. Dutta, Head of the Department of Entomology, Kalyani University for providing facilities.

DEPARTMENT OF ENTOMOLOGY,
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UNIVERSITY OF KALYANI,
KALYANI, WEST BENGAL,
February 17, 1971.

A. K. SOM CHOUDHURY[1]
A. B. MUKHERJEE

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[1] *Present address :* Division of Entomology, I.A.R.I., New Delhi-12.

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12. OCCURRENCE OF *MICROPROSTHEMA SEMILAEVE* (DECAPODA, MACRURA) IN RATNAGIRI

(*With three text-figures*)

During one of the shore collection trips to Mirkarwada foreshore in the month of December, 1968, a specimen of *Microprosthema* sp. measuring 14 mm in length was obtained. The animal was found in a small depression on the rocky bed. There is paucity of literature on this peculiar group from Indian waters. Gravely (1927) recorded *Microprosthema validum* Stimpson (= *Stenopus robustus* Borradaile) from Krusadai and Shingle Islands. Pillai (1961) recorded this species from Adams Bridge, Pamban, and gave a short description with a good figure. Recently, Mahadevan *et al.* (1962) collected two specimens from Palk bay which they have referred to as *Microprosthema semilaeve*?.

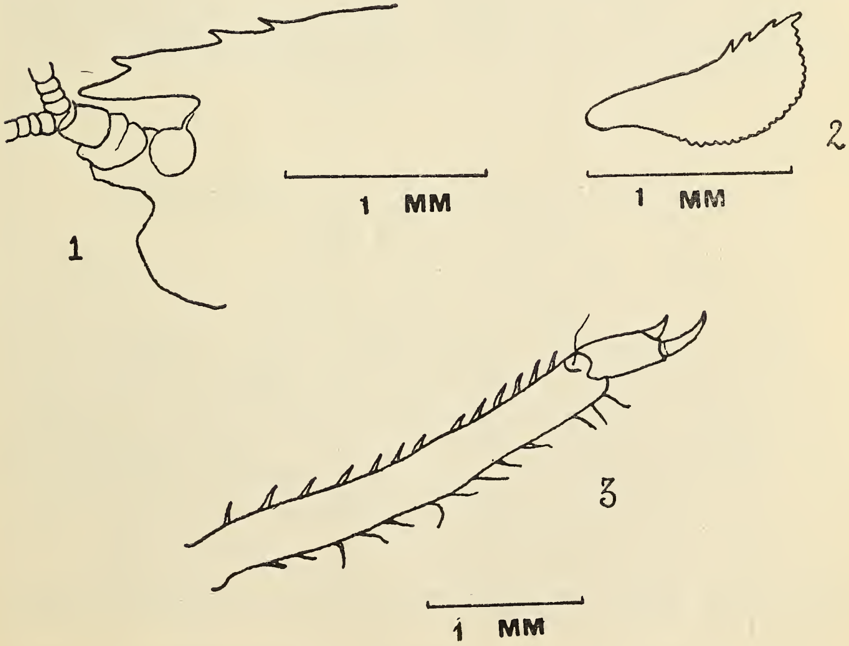
Holthuis (1947) who has given a detailed account of the family Stenopodidae has recognised four species of *Microprosthema* (*M. validum*, *M. semilaeve*, *M. plumicorne* and *M. scabricaudatum*). Of these *M. validum* and *M. semilaeve* are very close, differing from one another in the presence or absence of a short longitudinal median carina at the posterior half of the dorsal surface of the third abdominal segment and in the number of teeth along the outer margin of the scaphocerite. However, Mahadevan *et al.* (op. cit.) have shown that in their specimens the number of teeth on the outer margin of the scaphocerite show a range of variation which can embrace both the species, commenting that much reliance cannot be placed on this character in distinguishing the two species. Based on other characters such as the absence of the median longitudinal carina on the posterior half of the dorsal surface of the third abdominal segment, the uninterrupted nature of the transverse carina on the same segment and presence of a longitudinal shallow groove at the upper half of the inner margin of the carpus of the third periopod, they have tentatively referred their specimens to *M. semilaeve*, commenting that if much reliance cannot be placed on the character of presence or absence of the short longitudinal median carina at the posterior half of the dorsal surface of the third abdominal segment, then *M. semilaeve* should be treated as synonym of *M. validum*.

The local specimen shows more closeness to *M. semilaeve* in the following characters :

(1) Absence of a double row of spinules on the carapace behind the rostrum.
(2) The transverse carina on the third abdominal segment entire.
(3) The upper inner side of the carpus of the third periopod has a fairly deep longitudinal groove.
(4) Absence of medium longitudinal carina on the posterior half of the dorsal surface of the third abdominal segment.
(5) Ischium of the third maxillipede with four spines externally.
(6) Propodus and carpus of the fourth and fifth periopods undivided.

However, the local specimen differs from *M. semilaeve* in the following characters :

(1) Rostrum with three spines on the dorsal side and none on the ventral (fig. 1).
(2) Scaphocerite with four small teeth on the outer margin (fig. 2).
(3) Propodus of the fourth and fifth periopods with 13 movable spines (fig. 3).
(4) Uropodal exopods with 10 teeth and endopods with 4 teeth on the outer margin.
(5) Telson without teeth in between the two longitudinal carinae.



Microprosthema semilaeve : Fig. 1. Rostrum in lateral view ; Fig. 2. Scaphocerite of the left side ; Fig. 3. Propodus and dactylus of fourth periopod.

On the other hand the local specimen shows only one similarity with *M. validum* in having 4 teeth on the outer margin of the scaphocerite, a character which Holthuis considers as specific. However, considering the similarity of the local specimen with *M. semilaeve* given above and in the light of comments made by Mahadevan *et al.* (op. cit.) the present specimen is tentatively referred as *M. semilaeve*. This is thus the first record of this species from the west coast of India and second from Indo-Pacific region.

ACKNOWLEDGEMENTS

I am grateful to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, for encouragements and to Dr. H. G. Kewalramani, Senior Scientific Officer, for going through the manuscript and helpful criticism.

MARINE BIOLOGICAL RESEARCH
STATION, RATNAGIRI,
March 4, 1970.

M. R. RANADE

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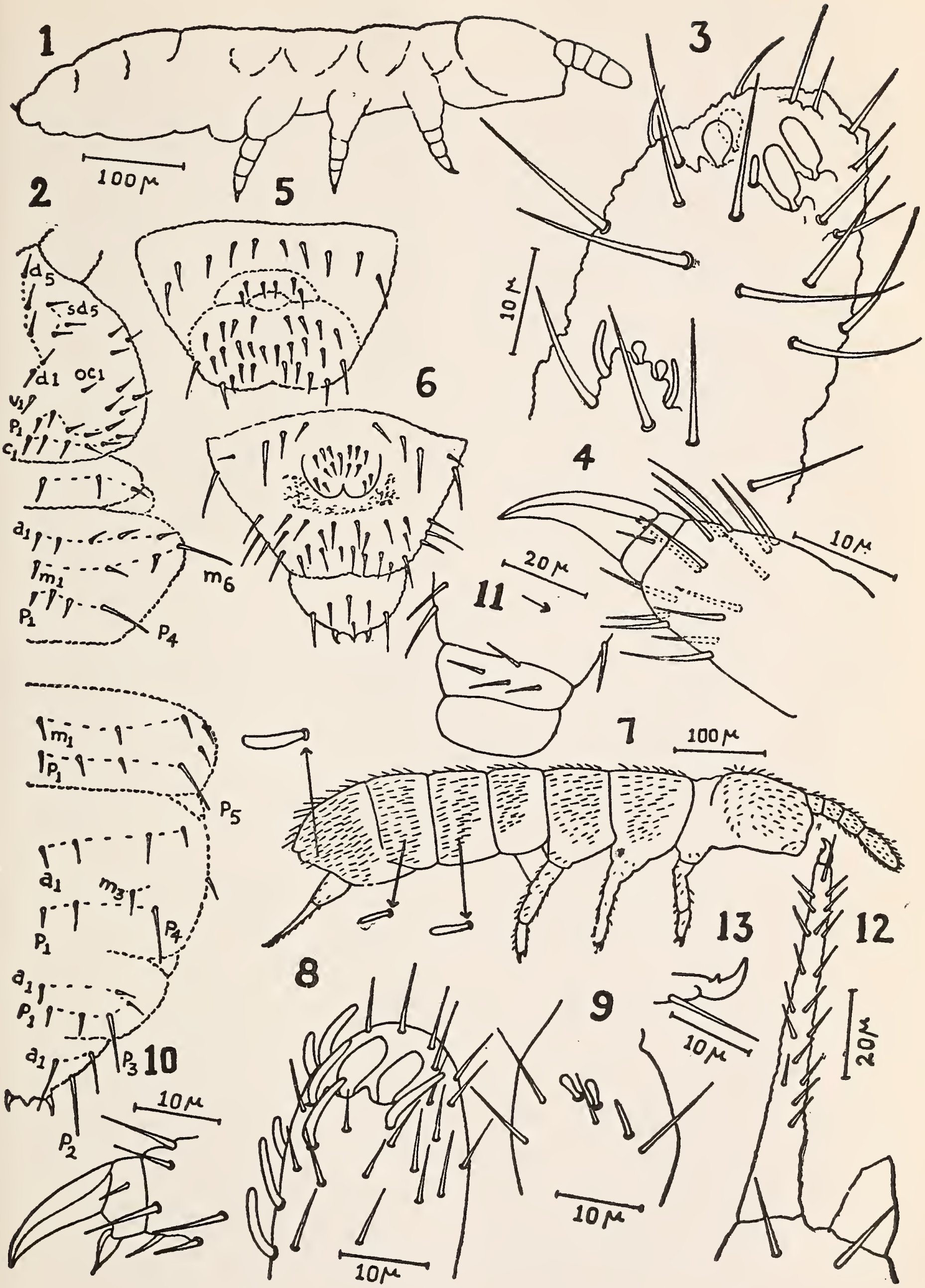
13. TWO NEW RECORDS OF SOIL COLLEMBOLA FROM SOUTH INDIA

(*With thirteen figures in a plate*)

About sixty species of soil and litter inhabiting Collembola have been reported by Prabhoo (1971 a, b) particularly from the western ghats in Kerala. These reports contain the majority of the widely distributed collembolan species of Kerala. The two species reported here seem to have a comparatively restricted range of distribution and further they show certain morphological features distinguishing them from conspecific populations described from other parts of the world.

Acherontiella bougisi Cassagnau and Delamare Deboutteville 1955 (Figs. 1-6)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Figs. 1-6. *Acherontiella bougisi* Cassagnau and Delamare Deboutteville. 1. Habitus. 2. Dorsal chaetotaxy of the right half. 3. Ant. III-IV. 4. Hind tibiotarsus and foot. 5. Female genital field. 6. Male genital field.

Figs. 7-13. *Folsomina onychiurina* Denis. 7. Habitus. 8. Ant. IV. 9. Ant. III sense organ. 10. Hind foot. 11. Ventral tube in profile. 12. Ventral side of furcula. 13. Mucro.

Material : 1 ♀ and 1 ♂ from soil, 9-1-1971, Nilakkamukku, Trivandrum Dt., Kerala, India. Coll. Haq.

Description : Body up to 600μ long and white in colour. Cuticle coarsely granulated. Clothing of smooth setae. Antennae slightly shorter than head. Ratio of antennal segments as 7 : 8 : 8 : 10. Ant. III organ composed of two stalked globular sense rods and two slender guard sense rods. Ant. IV dorsally with one globular sense club and externally with one globular and two elongated sense clubs and one short sense rod. Mandible with well developed molar area and four apical teeth. Maxilla head with fringed lamellae. Labrum with 6/5, 5, 4 setae, the distal four setae provided with basal sockets. Eyes and post-antennal organ absent. Claws without teeth. Unguiculus and tenent hair absent. Tibiotarsus with 15 setae. Furcula and tenaculum absent. Chaetotaxy of the body as in Fig. 2. On meso- and metanota m_6 and p_4 are sense setae (ss). On abd. I-III p_5 is ss. On abd. IV p_4 is ss. on abd. V p_3 is ss. On abd. VI p_1 is anal spine. The anal spines are short, as long as 1/5 the hind claw and mounted on short papillae.

Remarks : The Indian examples differ from the European form, whose chaetotaxy has been recently studied by Thibaud (1967), mainly in the following details of chaetotaxy ; head without a_0 ; ocularis with oc_1, the setae oc_2 and oc_3 being absent ; meso- and metanota without m_3 ; abd. I-III without a_2, a_4, p_4 ; abd. IV without m_1, m_4 and p_4. The chaetal nomenclature of Yosii (1961) is followed here.

Distribution : Europe (France), India (new record).

Folsomina onychiurina Denis (1931) (Figs. 7-13)

Material : 12 expl., from soil, 9-1-1971, Nilakkamukku, Trivandrum Dt., Kerala, India. Coll. Haq.

Description : Body up to 700 μ long and white in colour. Clothed with short smooth setae arranged in transverse rows. Abd. II, III and V with a sense rod each laterally. Antenna : head as 7/6 ; antennal ratio as 7 : 12 : 12 : 19. Ant. I with a ventral sense rod. Ant. III sense organ normal. Ant. IV apically with two stout sense clubs and eight sense rods. Eyes and post-antennal organ absent. Claws without teeth. Unguiculus less than 1/3 the hind claw. Tibiotarsal tenent hair absent. Ventral tube with 1 + 1 anterior, 4 + 4 lateral and 2 + 2 posterior setae. Rami tenaculi with 4 + 4 dents and corpus with one seta. Ratio of furcula as 9 : 15 : 1. Manubrium dorsally with 8 + 2 + 8 setae and ventrally with 1 + 1 setae. Dens with 4 setae on the proximal 1/3 and 19 setae ventrally arranged as v, v, oi, v, oi, oi, oi, ovi, oi, oi, v. Mucro hook-like and provided with a tooth-like short lateral lamella.

Remarks : The Indian form is characterised by the presence of a tooth-like lateral lamella on the mucro giving the latter a bidentate appearance.

Distribution : Cosmopolitan (?), new record for India.

ACKNOWLEDGEMENT

We are thankful to Professor K. K. Nayar for his keen interest in this study and for facilities provided in the department.

DEPT. OF ZOOLOGY,
UNIVERSITY OF KERALA,
TRIVANDRUM, KERALA,
May 22, 1971.

N. R. PRABHOO
M. ABDUL HAQ

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14. OCCURRENCE OF *RHINYPTIA MERIDIONALIS* V. *PUNCTICOLLIS* ARR. (SCARABAEIDAE : COLEOPTERA) AS PEST ON BAJRA IN WESTERN RAJASTHAN

Bajra (*Pennisetum typhoides* Stapf and Hubb.) is one of the most important crops in Western Rajasthan occupying more than 50% of the total crop area.

We observed *Rhinyptia meridionalis* v. *puncticollis* Arr. voraciously feeding on the milky grain of different varieties of *bajra* namely RSK, RSJ, Chandy, Improved Ghana, local Shekhavati of *bajra* in Churu areas, Hybrid *bajra*, HB-I, and local varieties in Mathania areas of Western Rajasthan. These Scarabaeid beetles are probably a new record as agricultural pests. Besides these, *Mylabris phalerata* Pall. and *Cantharis tenuicollis* Pall. (Coleoptera : Meloidae) caused considerable loss by sucking the juice of milky grain. In case of severe attack, the earhead of *bajra* was observed to be almost without any grain.

These pests are a great menace to the *bajra* crop in arid regions and require detailed investigation regarding their biology and bionomics in order to plan effective control measures. In a preliminary study during the year 1968-69 at Churu, monthly collections of *Rhinyptia meridionalis* v. *puncticollis* Arr. were made during full moon and new moon nights.

Observations were taken, two hours after sunset with the help of a petromax lamp in a fixed spot as the beetle is nocturnal in habit.

Out of the total collection (564) of the beetle 95·2% occurred during the crop season (July to November), 3·6% during the summer (March to June) and 1·2% during the winter (December to February). This indicates their predominant occurrence during the crop season. Marked differences were also observed in the frequency of the beetle during the nights of new and full moon. For instance, out of the total collection (537) of the beetles in crop season only 2·4% were observed during bright nights. Similarly out of total collection (20) of the beetles in summer, only 5% were collected on bright nights. These observations indicate that the beetles prefer dark night for their activity. Therefore suitable and timely control measures should be devised for minimising the loss in crop yield.

ACKNOWLEDGEMENTS

We are grateful to Dr. T. R. Mehta, Director and Dr. G. C. Taneja, Head of Division, for providing necessary facilities. Sincere thanks are also due to Shri A. C. Mathur, Forest Research Institute, Dehra Dun, for kindly identifying the insect species.

ANIMAL STUDIES DIVISION,
CENTRAL ARID ZONE RESEARCH INSTITUTE,
JODHPUR, RAJASTHAN,
April 6, 1971.

S. K. PAL
V. P. SHARMA

15. OCCURRENCE OF *LEPIDIUM VIRGINICUM* LINN. IN NETARHAT PLATEAU (BIHAR)

(*With a plate*)

While studying the flora of Netarhat Plateau, Bihar, in 1971, we collected some specimens of *Lepidium virginicum* Linn. (Brassicaceae) growing as a weed in gardens and lawns. In Indian Herbaria, this taxon has often been labelled as *L. ruderale* Linn.; the latter characterized by upper cauline leaves entire, petals much shorter than sepals or absent, silicula deeply notched, and incumbent cotyledons. The species is, however, very similar to *L. densiflorum* Schrad. but can be distinguished by its glabrate stems and flowers with white petals as long as or longer than sepals. *L. virginicum* Linn. is a native of North America and is widespread from the Atlantic Coast to the Rocky Mountains, W. Indies, Mexico, Central and South America. It is a new introduction into India and has not been reported earlier from Bihar State. The species has also been widely introduced and naturalized in Europe and some parts of the Old World (*see* Rydberg, Fl. Rocky Mts., ed. 2, 326. 1954; Vasconcellos in Fl. Europaea, Vol. 1, 332. 1964). The distinguishing features of the taxon are : cauline leaves not auriculate ; upper cauline leaves dentate or incised ; flowers white, with 4 petals as long as or slightly longer than the sepals ; silicula 2·5-4 × 2·5-3·5 mm, orbicular-ovate or suborbicular, with shallow apical notch ; and accumbent cotyledons. The specimens have been deposited in the Herbarium of National Botanic Gardens, Lucknow (S. R. Paul 81073, Herb. LWG). The botanical nomenclature of this species, naturalized in different parts of India, is presented below :

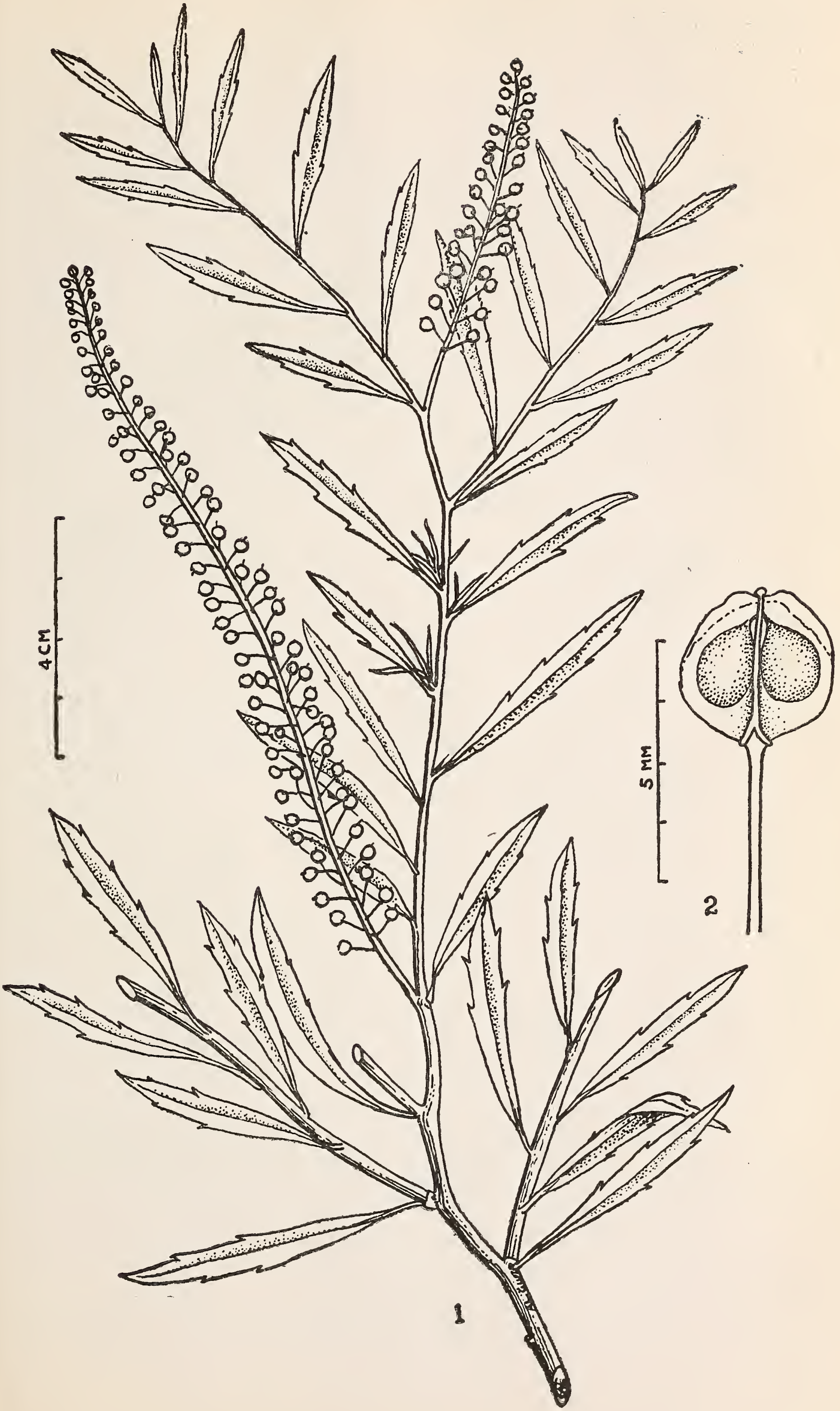
Lepidium virginicum Linn. Sp. Pl. 645. 1753 ; Jepson, Man. Fl. Pl. California 439. 1951 ; Strausbaugh & Core, Fl. W. Virginia 424. 1953 ; Wills & Irwin, Roadside Fl. Texas 118. 1961 ; Steyermark, Fl. Missouri 738. 1963 (Plate, Figs. 1 & 2).

Common names : Virginia Peppergrass ; Birds Pepper; Virginia Pepperweed.

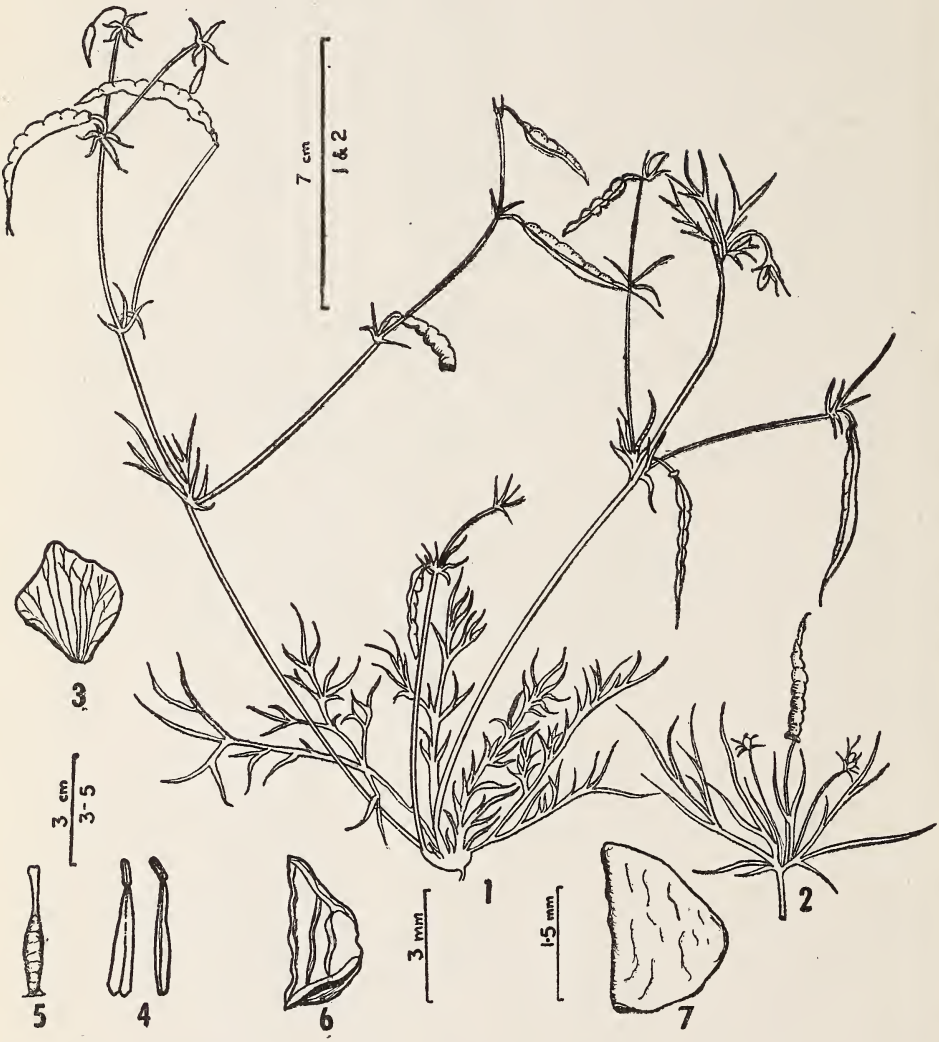
Notes : Virginia Peppergrass, named for its pungent seeds and narrow grass-like leaves, is usually a weedy plant and is frequently abundant in disturbed places, such as vacant lots, fallow fields and neglected lawns. The peppery seed pods are relished by birds and in this way, plants are often disseminated. The seeds furnish tasty seasoning for soups and salads, and can be mixed with vinegar and salt for a meat dressing. The young spring shoots can be eaten raw sprinkled in salads as a substitute for water cress.

FLORISTIC BOTANY DIVISION,
NATIONAL BOTANIC GARDENS,
LUCKNOW,
January 22, 1973.

J. K. MAHESHWARI
S. R. PAUL



Lepidium virginicum Linn.
Fig. 1. Fruiting twig. Fig. 2. Silicula.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7

1. *Hypecoum procumbens* Linn. 1. a plant; 2. a node bearing a fruit—enlarged view; 3. a petal; 4. stamens; 5. a carpel; 6. one of the joints of the subcompressed fruit; 7. seed.

16. *LIMNOCHARIS FLAVA* (L.) BUCH. AN AQUATIC PLANT ON THE MOVE IN KERALA STATE

During the recent ecological study tour to coastal Kerala we observed and collected *Limnocharis flava*, a robust water plant from a number of sites along the fringes of canal banks and paddy fields in Tirchur and its vicinity. From the field survey, it is obvious that this adventive plant is making a fast headway northwards at several places in the Trichur District bounded on the north by Palghat, on the east by Coimbatore, on the south by Ernakulam and Kottayam districts and on the west by Arabian sea. In the year 1961, this plant was collected at Alleppey. Subsequently in the year 1967 it was collected and reported from Ambalapuzha (Kammathy *et al.* 1967).[1] Undoubtedly this aquatic herb is gradually establishing itself everywhere and if early steps are not taken to eradicate this weed it may become a pest in the same way as *Salvinia natans* (Linn.) All. or *Eichhornia crassipes* (Mart.) Solms.

Specimens examined. Kerala. Trichur Dt: Trichur, 7.11.1972, T. A. Rao 9796 (CAL). Kerala. Alleppey Dt.: Alleppey; 30.10.1961, Ramachandran s.n. (CAL); Ambalapuzha, 5.2.1967, Kammathy 64 (CAL).

Ecology Section,
Botanical Survey of India,
76, Acharya Jagadish Bose Road,
Calcutta-14,
February 7, 1973.

T. ANANDA RAO
G. C. DAS

17. SOME PLANT RECORDS FOR RAJASTHAN

(*With a plate*)

Much work has recently been done on the Flora of the various parts of Rajasthan. However, no Flora of Rajasthan as such has been published. As far as Ganganagar is concerned, no systematic work has ever been published concerning its vegetation. Ganganagar district, which is now a land of greenery, was all barren, scattered over with heaps of sand-dunes prior to 1927-28, when the Gang canal was constructed. The face of this desert has been completely changed with the coming of this canal. Green fields have replaced the desolate wastes. This change has affected the natural vegetation of the entire region. New plants from the hilly areas of the Punjab have spread downwards and have established themselves all along the banks of the canals or are found as seasonal weeds in the irrigated areas. Since these plants are not found in other parts of Rajasthan, it is worth reporting them as new records for Rajasthan. Out of the sixteen species mentioned in this note, almost all of them have not been reported from any part of Rajasthan previously. The specimens have been deposited in the Herbarium of the University of Jodhpur and the duplicates at the Botany Department, Khalsa College, Ganganagar and one set of the specimens at Forest Research Institute, Dehra Dun and National Herbarium, Calcutta.

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[1] Kammathy, R. V. & Subramanyam, K. (1967) *Limnocharis* H.B.K. A genus new to India. *J. Bombay nat. Hist. Soc.* **64**: 389-390.

Hypecoum procumbens Linn. Sp. Pl. 124. 1753 ; FBI. 1 : 120. 1872.

A small procumbent annual. Leaves 2-3-pinnatisect. Flowers few, yellow, pedicillate ; outer petals 3-lobed, inner toothed or fimbricate, obtuse with mid-lobe entire, retuse or 2-fid. Fruit subcompressed, at length breaking into 1-seeded joints (Fig. 1).

Fl. & Fr. :—Jan-March.

Specimens examined : *Dhillon* 244, Chak 3Z, 29.3.67.

Distr. :—India (Part of Punjab), W. Pakistan, W. Asia, Mediterranean region.

BRASSICACEAE

Malcolmia africana R. Br. in Ait. Hort. Kew ed. II 4 : 121. 1872 ; FBI. 1 : 146. 1872.

A stout, stellate hairy plant with oblong slightly dentate, broad leaves and long pods.

Fl. & Fr. :—Feb.-March.

Specimen examined : Dhillon 88, Khalsa College Farm, 13.3.67.

Distr. :—India (Punjab, Kashmir), Tibet, W. Asia, Mediterranean region.

FABACEAE

Medicago denticulata Willd. Sp. Pl. 3 : 1414. 1802 : FBI. 2 : 9. 1876; *M. polymorpha* Roxb. Fl. Ind. 3 : 390. 1832.

A prostrate herb with lacinate stipules. Flowers 1-5 on peduncle, yellow. Pods netted, disc-shaped, spiral, with usually variable number of spines.

Fl. & Fr. :—Jan.-March.

Specimens examined : *Dhillon* 133, Khalsa College, Farm, 23.3.67.

Distr. :—India (Punjab, Himalayas, Bengal), W. Pakistan, China. Japan, Siberia, Europe etc.

APIACEAE

Oenanthae javanica (Bl.) Dc. Prodr. 4 : 138 1830 ; *Sium javanicum* Bl. Bijdr. 15 : 881. 1826 ; *Oenanthae Stolonifera* DC. Prodr. 4 : 138. 1830 ; FBI. 2 : 696. 1876.

A stoloniferous, glabrous, fistular herb, 45-80 cms high. Leaves unipinnate : petiole sheathed. Flower white, fragrant, in compound umbels. Cremocarps dorsally compressed.

Fl. & Fr. :—April-Oct.

Specimens Examined : Dhillon 44, Sadhuwali, 19.8.66.

Distr. :—India (Kashmir, Punjab, Assam ; plains of Bengal) Java, China, Japan.

Psammogeton biternatum Edgew. in Trans. Linn. Soc. 20 : 57. 1846 ; FBI. 2 : 719. 1879.

Segments or lower leaves ovate, pinnatifid into narrow lobes, of the upper narrowly cuneate, lacinate, hairs on the ridges, white, capitellate, longer than the carpel.

Fl. & Fr. :—Feb.-March.

Specimens examined : Dhillon 149, Khara chak on Hanumangarh Road, 25.3.67.

Distr. :—India, Punjab, ascending up to 300 ft. in Himalayas ; W. Pakistan.

ASTERACEAE

Cirsium wallichii DC. Prodr. 6 : 643. 1837 ; *Cnicus wallichi* (DC.) Hook. f. in FBI. 3 : 363. 1880.

A variable plant 1-3 m high. Stem pubescent leafy. Leaves sessile, sinuate—pinnatifid. Heads 2-4 cm, solitary or on peduncles fascicled, involucrate.

Fl. & Fr. :—Feb.-March.

Specimens examined : Dhillon 155, Lyallpur. Fruit Farm, 25.3.67.

Distr. :—India (Temperate Himalayas, Kashmir, Nilgiris), Bhutan.

Ifloga fontanesii Cass. in Dic. Sc. Nat. 23 : 14. 1822 ; FBI. 3 : 277. 1881.

A much branched, ascending, leafy annual. Leaves spreading, narrowly linear. Heads 2-3 nate, nestling among the leaves throughout the length of branches : Involucre reddish. Bracts scarius, aristate.

Fl. & Fr. :—Feb.-April.

Specimens examined : Dhillon 161, Govt. College Campus, 26.3.67.

Distr. :—India (Upper Gangetic plains) Westwards to Canaries.

SCROPHULARIACEAE

Antirrhinum orontium Linn. Sp. Pl. 860. 1753 ; FBI. 4 : 253. 1883 ; *A. gibbosum* Wall. Pl. As. Rar. 2 : 44. 1930.

A glandular, slender herb, 15-45 cm high. Leaves 2·5 × 2-0·3 cm linear, entire. Flowers solitary axillary, white or pinkish, Capsule pubescent.

Fl. & Fr. :—Feb.-April.

Specimens examined : *Dhillon* 78, College lawns and College Farm, 13.3.67.

Distr. :—(Punjab plains & W. Himalayas up to 4000 ft. and common in Nilgiris), Westwards to N. Africa & Britain, Egypt, Arabia, Syria and Greece.

PLANTAGINACEAE

Plantago amplexicaulis Cav. Icon. 2 : 22. 125. 1799 ; FBI. 4 : 706. 1885.

A scapigerous herb, subcaulescent, 5-10 cm high. Leaves 7-15 cm margins entire or very sparingly toothed. Spikes 1·5-2·5 cm boat-shaped, bracts cupular.

Fl. & Fr. :—Jan.-Feb.

Specimens examined : *Dhillon* 304, Khalsa College Farm, 13.3.68.

Distr. :—India, (Punjab), W. Pakistan, Egypt.

POLYGONACEAE

Polygonum barbatum Linn. Sp. Pl. 362. 1753 ; Royle I.11. 313 ; FBI 5 : 37.

An erect, glabrous annual. Leaves linear, lanceolate, acuminate tapering to the acute base, glabrous. Stipules strigose. Peduncles glabrous. Raceme 5-10 cm perianth white, eglandular. Stamens 5-8. Styles 3-cleft. Nutlets trigonous.

Fl. & Fr. :—Almost throughout the year.

Specimens examined : *Dhillon* 17, Z canal, 13.8.66.

Distr. :—India (Assam, Bengal, M.P., S. India), W. Pakistan, Ceylon, Burma, Malay peninsula, China, Japan. Tropical Africa.

Polygonum lanigerum R. Br. Prod. 419. 1810 ; FBI. 5 : 1886.

A robust annual 1-2 m high. Stem prostrate rooting at the nodes below, clothed with snow-white tomentum, branches deep red within node's Leaves shortly stalked, narrowly lanceolate acuminate, densely white cottony beneath. Stipules membranous. Raceme 2 to 5 cm long. Bracts densely white woolly, crowded, Stamens 6 style 2-cleft.

Fl. & Fr. :—Aug.-Sept.

Specimens examined : *Dhillon* 55, Sadhuwali, 19.8.67.

Distr. :—

POACEAE

Alloteropsis cimicina (Linn.) Stapf. in Prain, Fl. Trop. Africa 9 : 487. 1919 : Bor, Grasses Ind. etc. 276. 1960 ; *Milium cimicinum* Linn. Mant. Alt. 184. 1771 ; *Axonopus cimicinum* P. Beauv. Ess. Agrost. 12, 1812 ; FBI 7 : 64. 1896.

An erect or procumbent grass. Culms & leaf margins clothed with long, horizontal cilia. With somewhat swollen nodes. Leaf margins clothed with long bulbous-based cilia. Racemes spike-like, occurs sporidically in moist, stony ridges and fissures.

Fl. & Fr. :—Almost throughout the year.

Specimens examined : *Dhillon* 32b, Sohan Lal orchard, Ganganagar 20.3.68.

Distr. :—Throughout India (in the plains of lower foot-hills) Burma, Ceylon, Trop. Africa and Australia.

Hemarthria compressa (Linn. f.) R. Br. Prodr. 207. 1810 ; Bor. Grasses Ind. etc. 161. 1960 ; *Rotboellia compressa* Linn. f. Suppl. 114, 1781 ; FBI 7 : 153 : 1896.

A perennial, hygrophilous, erect or decumbent grass, usually branched and leafy throughout. Spikes solitary or fascicled.

Fl. & Fr. :—June-September.

Specimens examined : *Dhillon* 60, Z canal, 20.8.66.

Distr. :—Throughout the hotter parts of India, Ceylon, Burma and Malaysia.

Imperata cylindrica (Linn.) Beavu. Agrost. 165, t. 5, f. 1. Planch 5. 1812 ; Bor, Grasses Ind. etc., 169, 1960 ; *Langrus cylindrica* Linn. Syst. 878, 1759 ; I. *arundinacea* Cyr. Pl. Rar. Neap. 2 : 26. t. 11. 1792 ; FBI 7 : 106. 1895.

An erect or creeping annual grass. Panicle cylindrical and silvery white. Anthers orange.

Fl. & Fr. :—June-Oct. & Jan.-April.

Specimens examined : *Dhillon* 337, Lyallpur Farm, 13.3.68.

Distr. :—Mediterranean region extending to Iraq, Iran, Afghanistan (arid region) & U.S.S.R.

Lolium temulantum Linn. Sp. Pl. 83. 1753 ; Bor, Grasses Ind. etc. 546. 1960.

An annual, tufted grass, with erect spikes. Spikelet 5 to 10 flowered.

Fl. & Fr. :—Dec.-April.

Specimens examined : Dhillon 339, Khalsa College Farm, 13.3.68.

Distr. :—Native of mediterranean region, now extended into many parts of the world in the wheat fields.

Lophochloa pumila (Desf.) Bor, Grass. Ind. etc. 445. 1960 ; *Avena pumila* Desf. Fl. Atlant. 1 : 103, 1798.

Tip of the lemma not produced into 2 awns, glumes subequal, densely and shortly hairy, rachilla always produced, clothed with long hairs.

Fl. & Fr. :—July-Sept.

Specimens examined : Dhillon 340, Khalsa College Farm, 19.8.68.

Distr. :—Northwest India to Mediterranean region.

KHALSA COLLEGE,
GANGANAGAR, (RAJASTHAN).
K. B. S. DHILLON

BOTANY DEPARTMENT,
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JODHPUR, (RAJASTHAN),
March 3, 1972.
M. M. BHANDARI

18. ALGAE OF NAINITAL

In this paper, 58 taxa belonging to Cyanophyceae, Chlorophyceae, Euglenophyceae and Xanthophyceae are recorded for the first time. These algae have been collected during a botanical excursion in October 1970.

Nainital is situated at 29°24′N lat. 69°28′E long. in the valley of Gager range on Kumaon Himalayas at an altitude of 1920 metres above m.s.l. The rainy season is from the middle of June to September and the average yearly rainfall is about 254 cms.

Rhizoclonium hieroglyphicum (Ag.) Kuetz. appears to be the common alga. A number of species of *Spirogyra* and *Oedogonium* were present in vegetative condition only and hence could not be identified. Diatoms are present in good numbers in the collections and are being studied.

CYANOPHYCEAE

Synechococcus aeruginosus Naeg.

In a pond on way to Hanumangad. Cells 14-16 μ broad.

Synechocystis crassa Woronichin

In a puddle.

Aphanothece bullosa (Menegh.) Rabenh.

Irregular, mucilaginous masses on dripping rocks, Bhowali Road.

Aphanothece conferta Richter

Ellipsoidic, microscopic masses floating in a puddle on way to Hanumangad.

Gloeothece palea (Kuetz.) Rabenh.

In a puddle, on way to Bhowali.

Merismopedia punctata Meyen

Rare. In Naini lake.

Chroococcus minutus (Kuetz.) Naeg.

In a puddle on way to Hanumangad.

Chroococcus turicensis (Naeg.) Hansg.

In a puddle.

Microcystis flos-aquae (Wittr.) Kirchner

Floating in a pond, Bhowali.

Myxosarcina burmensis Skuja

In a pool.

Endospores not observed.

Xenococcus kerneri Hansg.

Epiphytic on *Cladophora* in a pond, Bhowali.

Chamaesiphon siderphilus Starmach v. *glabra* Rao

Epiphytic on *Cladophora* sp. in a pond.

Spirulina nordstedtii Gom.

Common. In ponds, puddles.

Spirals slightly less in breadth being 4-4·5 μ broad. Distance between two consecutive spirals is 3-3·5 μ.

Oscillatoria pseudogeminata G. Schmid

In Naini lake.

Oscillatoria rubescens D.C. ex Gomont

On shore of Naini lake. In gutters. On moist soils.

Oscillatoria splendida Grev. ex Gomont v. *attenuata* W. et G. S. West

In a puddle.

Phormidium africanum Lemm.

On moist soil.

Phormidium corium Gom. v. *capitatum* Gardner

On moist soil near a puddle on way to Naini peak. Cells 6·45-13 μ long.

Phormidium frigidum Fritsch

In a puddle.

Phormidium lucidum Kuetz. ex Gom.

In Naini lake.

Trichomes smaller, 6 μ broad.

Phormidium molle Gom.
On moist soil, Bhowali road.

Phormidium subincrustatum Fritsch et Rich

In Naini lake.

Lyngbya digueti Gomont

In a puddle.

Lyngbya lagerheimii (Moeb.) Gom.

In Naini lake.

The filaments are not planktonic. They are 2·6 μ broad; trichomes 2.2-2.4 μ broad; cells 1·6-3.2 μ long.

Lyngbya nordgardhii Wille

Epiphytic on *Rhizoclonium* sp. floating in a pond on way to Bhowali.

Schizothrix braunii (A. Br.) Gom
Forming a leathery mass on the dripping rocks on way to Bhowali.

Nostoc commune Vauch. ex Born. et Flah.

Irregular, firm masses on dripping rocks.

Nostoc microscopicum Carm. ex Born. et Flah.

On dripping rocks on way to Bhowali. Spores not observed.

Nostoc paludosum Kuetz. ex Born. et Flah.

In Naini lake.

Colonies up to 70 μ diam. and cells up to 5 μ broad.

Calothrix stellaris Born. et Flah.

In a puddle on way to Hanumangad. Cells mostly not constricted.

CHLOROPHYCEAE

Ankistrodesmus falcatus (Corda) Ralfs v. *acicularis* (A.Br.)

G. S. West.

In Naini lake.

Cells usually curved.

Oocystis naegelii A. Braun

Common in a puddle on way to Hanumangad.

Pediastrum integrum Naeg.

In a puddle on way to Bhowali. Colonies usually irregular in shape.

Ulothrix tenerrima Kuetz.

In puddles.

Two pyrenoids were present in almost all the cells and in this respect it agrees well with *U. bipyrenoidosa* Fritsch et Rich. However in general structure the present alga agrees more to *U. tenerrima*.

Microspora pachyderma (Wille) Lagerh.

In a puddle.

Cylindrocapsa gemenella Wolle

In a small pond.

Coleochaete orbicularis Pringsheim

Epiphytic on *Hydrilla* plants in Naini lake.

Rhizoclonium hieroglyphicum (Ag.) Kuetz.

Common. In puddles, ponds and a lake.

Rhizoclonium hieroglyphicum (Ag.) Kuetz. v. *horsfordii* (Wolle) Collins

In puddles, ponds.

Cladophora glomerata (L.) Kuetz. Common. In puddles, ponds.

Closterium acutum Bréb.

In Naini lake.

Closterium lanceolatum Kuetz.

In a puddle on way to Bhowali.

Closterium moniliferum (Bory) Ehrenb. v. *concavum* Klebs

In a puddle.

Closterium tumidulum Gay

In Naini lake.

Cells are longer up to 170 μ long.

Closterium venus Kuetz.

In a puddle.

Cosmarium fontigenum Nordst.

In a pool.

Cosmarium fontigenum Nordst. v. *pseudofontigenum* (Gutw.) West et West

Common. In puddles.

Cosmarium garrolense Roy et Bisset

In a puddle.

Cosmarium garrolense Roy et Bisset v. *pyramidatum* Kriger

In Naini lake.

Cosmarium laeve Rabenh. v. *acervatum* Forster

In a puddle.

Cosmarium venustum (Bréb) Arch. v. *induratum* Nordstedt

Rare. In Naini lake.

Staurastrum gracile Ralfs

In a puddle.

Spirogyra gracilis (Hassall) Kuetz.

In a puddle.

EUGLENOPHYCEAE

Lepocinclis ovum (Ehrenb.) Lemm.

In a small pool.

Phacus pleuronectes (O.F.M.) Dujardin

In a puddle.

Phacus unguis Pochmann

In a pond on way to Bhowali.

Trachelomonas volvocina Ehrenb.

Common. In pools, puddles, Naini lake.

XANTHOPHYCEAE

Tribonema bombycinum (Ag.) Derbes et Solier

In ponds.

ACKNOWLEDGEMENTS

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February 5, 1972.

N. D. KAMAT

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19. FURTHER CONTRIBUTION TO THE FLORA OF BAILADILLA (MADHYA PRADESH)

Bailadilla, a remote hill range in Bastar district of Madhya Pradesh, is about 402 kilometres south of Raipur on the South-Eastern Railways. Owing to its vast resources of high quality iron ore, the hill gained enough importance in recent years with the starting of iron ore project. It lies between 18·30 and 19·5° north and 81·10 and 81·15° east, ranging in altitude from 900 to 1276 metres.

The botany of Bailadilla is interesting as it includes a number of species otherwise occurring in Himalayas and south Indian hills. A number of west and east Indian elements and also a few coastal form also make their appearance in this east central Indian hill.

The flora of the area has been studied by several workers. However in the past.

The following list of 65 species of vascular plants are being reported for the first time from the area. Two species out of these are new records for Madhya Pradesh (marked by single asterisk) and four for Central India (marked by double asterisk). This paper is the outcome of several collection tours made in the area in different seasons for four years. The specimens cited, are preserved in the herbarium of the State Forest Research Institute, Jabalpur.

PITTOSPORACEAE

****Pittosporum nepaulense** (DC.) Rehder ex Wilson var. **rawalpindiense** Gowda
Bailadilla. *Khotele* 8050.

MALVACEAE

Abelmoschus moschatus Medic
Loc. name : *Gumamata.*
Kirandul. *Singh* 4216.

Abutilon polyandrum (Roxb.) W. & A.
Bailadilla. *Hewiston* s.n.

Hibiscus tetraphyllus Roxb.
Kirandul. *Saxena* 1365.

Sida veronicaefolia Lam.
Kirandul. *Saxena* 1386.

TILLIACEAE

Corchorus olitorius Linn.
Kirandul. *Saxena* 1358.

Triumfetta pilosa Roth
Kirandul. *Saxena* 1400; *Singh* 4258.

LINACEAE

Reinwardtia indica Dumort
Bailadilla. *Singh* 4274.

OXALIDACEAE

Oxalis corniculata Linn.
Kirandul. *Singh* 6766.

PAPILIONACEAE

Alysicarpus vaginalis (Linn.) DC.
Loc. name : *Bhui Kurwa, Phadkuli.*
Bailadilla. *Singh* 4366.

Atylosia scarabaeoides (Linn.) Benth.
Bailadilla. *Saxena* 1352.

Desmodium velutinum (Willd.) DC. var. **velutinum**
Loc. name : Badi Chat Kani.
Kirandul. *Singh* 2568.

Teramnus labialis (Linn. f.) Spreng.
Bailadilla. *Singh* 2567.

Zornia gibbosa Spanoghe
Bailadilla. *Khotele* 10295.

MIMOSACEAE

Acacia pennata (Linn.) Willd.
Kirandul. *Singh* 2507, 4222.

CUCURBITACEAE

Cucumis sativus Linn.
Kirandul. *Singh* 2590.

Diplocyclos palmatus (Linn.) Jaffrey
Kirandul. *Singh* 2593.

Melothria maderaspatana (Linn.) Cogn.
Kirandul. *Singh* 2540.

RUBIACEAE

Hedyotis hispida Retz.
Kirandul. *Singh* 4212.

Konotheca ovatifolia (Cav.) Sant. & Wagh
Kirandul. *Saxena* 1366.

Rubia cordifolia Linn.
Bailadilla. *Saxena* 1294, *Singh* 4273.

COMPOSITAE

Bidens pilosa Linn.
Kirandul. *Singh* 214.

Blumea virens DC.
Bailadilla. *Saxena* 1285; *Khotele* 8358.

Centanthrum anthelminticum (Willd.) O. Ktze.
Kirandul. *Singh* 2530.

Conyza canadensis (Linn.) Conquist; Cuatr. in Webbia 24: 222, 1969 Syn. *Erigeron canadensis* Linn.
Bailadilla. *Singh* 6796.

Cosmos sulphureus Cav.
Kirandul: escape. *Singh* 2546.

Crassocephalum crepidioides. (Benth.) S. Moore Syn. *Gynura crepidioides* Benth.
Bailadilla. *Khotele* 9023.

Guizotia abyssynica Cass.
Bailadilla: escape. *Singh* 4321.

Siegesbeckia orientalis Linn.
Loc. name: *Katkan*
Bailadilla. *Singh* 4318.

Sonchus asper Vill.
Kirandul. *Singh* 2259.

PRIMULACEAE

Lysimachia obovata Hk. f.
Bailadilla: in shady places. *Singh* 2274.

OLEACEAE

Jasminum officinale Linn.
Bailadilla: escape. *Singh* 6638.

BORAGINACEAE

Cynoglossum lanceolatum Forsk.
Bailadilla. *Singh* 2266.

CONVOLVULACEAE

Argyreia sericea Dalz.
Kirandul. *Singh* 2573.

Ipomoea eriocarpa R. Br.
Kirandul. *Singh* 2595.

ACANTHACEAE

Dipteracanthus prostratus (Poir.) Nees
Bailadilla. *Singh* 2284.

VERBENACEAE

Callicarpa macrophylla Vahl
Bailadilla. *Khotele* 6077.

LABIATAE

Micromeria biflora Benth.
Bailadilla. *Singh* 4336.

Ocimum americanum Linn.
Loc. name: *Vantulsi*
Bailadilla. *Singh* 2257.

POLYGONACEAE

Polygonum stagninum Buch.-Ham.

Kirandul. *Singh* 4211.

EUPHORBIACEAE

***Cleistanthus patulus** Muell.-Arg.

Bailadilla, along stream. *Khotele* 9013.

Phyllanthus urinaria Linn.

Bailadilla. *Khotele* 6082.

ORCHIDACEAE

Acampe praemorsa (Roxb.) Blatter & McCann. Syn. *Saccolobium wightianum* Hk. f.

Kirandul. *Saxena* 1459; *Khotele* 8096.

ZINGIBERACEAE

Curcuma aromatica Salisb.

Kirandul. *Khotele* 8080.

Globba racemosa Sm.

Bailadilla. *Khotele* 8077.

****Zingiber capitatum** Roxb. *Loc. name: Zerkan.*

Bailadilla. *Singh* 6798.

LILIACEAE

Asparagus gracilis Royle. *Loc. name: Muli Muthore Dokin Jade.*

Bailadilla. *Singh* 2296.

COMMELINACEAE

Cyanotis axillaris R. & S.

Bailadilla. *Singh* 2271.

ARACEAE

Arisaema tortuosum Schott.

Kirandul. *Singh* 2591.

Remusatia vivipara (Lodd.). Schult.

Kirandul. *Saxena* 1397; *Khotele* 8058.

CYPERACEAE

Cyperus melanosperma (Nees) Suringer. *Loc. name: Rodaghas.*

Near Kirandul, along stream. *Singh* 2521.

****Elaeocharis chaetaria** R. & S.

Bailadilla hill top in moist places. *Singh* 4343.

Fimbristylis littoralis Gaud.

(*F. miliacea* sensu. C.B. Cl. in Fl. Brit. Ind.)

Kirandul. *Singh* 2526, 4339.

Eleusine coracana (Linn.) Gaertn.

Bailadilla. *Singh* 4327.

Eragrostiella brachyphylla (Stapf) Bor

Bailadilla. *Singh* 6603.

Eragrostis viscosa (Retz.) Trin.

Kirandul. *Singh* 4290.

Eulalia trispicata (Schult.) Henr.

Kirandul. *Singh* 2559.

Panicum notatum Retz.

Kirandul. *Singh* 2520.

Panicum psilopodium Trin.

Bailadilla. *Singh* 4291.

Panicum sumatrense Roth.
Kirandul. *Singh* 4324 ; *Khotele* 8092.

Pseudopogonatherum contortum (Brongn.) A. Camus
Kirandul. *Singh* 2561.

ASPIDIACEAE

***Cyclosorus parasiticus** (Linn.) Tardien ex. Tardien & C. Chr.
Syn. *Dryopteris parasitica* (Linn.) O. Ktze.
Kirandul. *Singh* 2544.

ASPLENIACEAE

****Asplenium dalhousiae** Hook.
Syn. *Ceterach dalhousiae* (Hook.) C. Chr.
Bailadilla. *Singh* 4294.

ACKNOWLEDGEMENTS

The author is grateful to the Director, National Botanic Garden, Lucknow, to Dr. J. K. Maheshwari, Asst. Director, National Botanic Garden, Lucknow ; to the Director, State Forest Research Institute, Jabalpur ; to the Conservator of Forests, Bastar Circle, Bastar ; to the Divisional Forest Officer and Staff of the South Bastar Division ; to the Director, Botanical Survey of India, Calcutta ; to the President, F.R.I., Dehra Dun ; to the Officer-in-Charge, Botany Branch, F.R.I. Dehra Dun and to the Regional Botanist, Botanical Survey of India, Central Circle, Allahabad for their kind co-operation in various ways.

SCIENTIST,
REGIONAL RESEARCH LABORATORY,
BHUBANESWAR, ORISSA,
November 6, 1971.

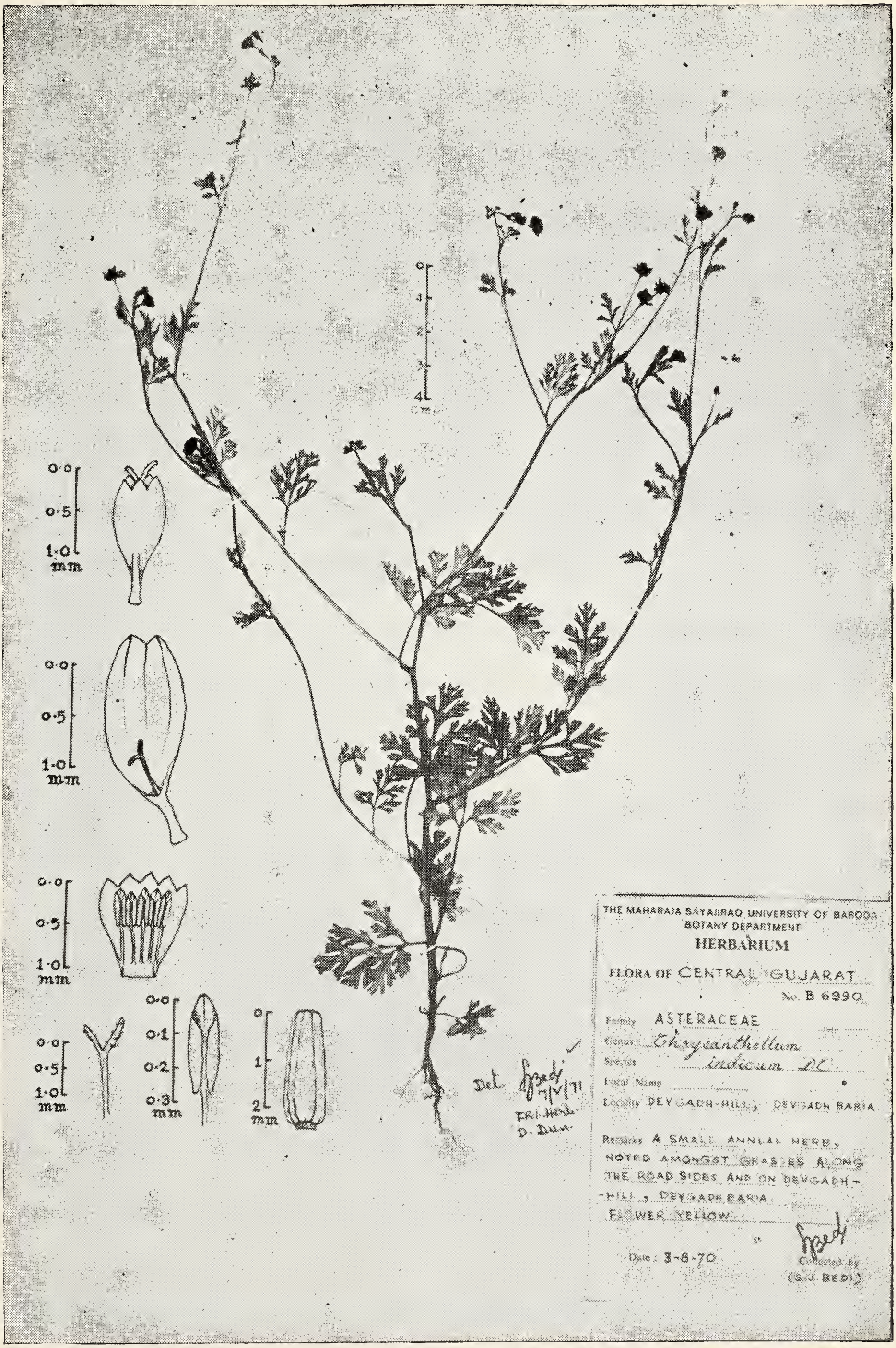
H. O. SAXENA

20. THE OCCURRENCE OF *CHRYSANTHELLUM INDICUM* DC. IN GUJARAT STATE

(*With a plate*)

During the course of botanical explorations of Panch Mahal district, Central Gujarat, *Chrysanthellum indicum* DC., was collected. So, as far as could be ascertained from the available literature, this species seems to be a new record for this region and most probably for the W. India.

Bedi & Thaker: *Chrysanthellum indicum*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F.R.I. Herb.
D. Dun.

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
BOTANY DEPARTMENT
HERBARIUM

FLORA OF CENTRAL GUJARAT
No. B 6990

Family ASTERACEAE
Genus Chrysanthellum
Species indicum DC.
Local Name
Locality DEVGADH-HILL, DEVGADH BARIA

Remarks A SMALL ANNUAL HERB, NOTED AMONGST GRASSES ALONG THE ROAD SIDES AND ON DEVGADH-HILL, DEVGADH BARIA. FLOWER YELLOW.

Date: 3-8-70
Collected by
(S. J. BEDI)

Chrysanthellum indicum DC., Prod. v, 631 ; FBI. 3 : 310

A small, erect, annual, glabrous herb, 10 to 40 cm tall, leaves alternate, bipinnatifid, 2 to 8 cm long. Segments lobed or cut, final segments broadly linear or cuneate. Heads peduncled, yellow, 3 to 5 mm in diameter in flower and 5 to 7 mm in fruit, with the invol. bracts spreading, golden-yellow. Achenes 3 mm long, linear-oblong, sub-compressed, outer thick, tubercled externally, 3-grooved on each face, inner ridged on each face ; pappus a minute corona.

The plants, though not common, were found growing on open grassy places on hilly forest slopes of Devgadh hill and along the roadsides near Baria Palace, Devagadhbaria, Panch Mahal District, Gujarat State.

Flowering and Fruiting time : July to August.

Herbarium specimen No. BEDI 6990 (3-8-1970).

This species has been earlier reported from upper gangetic plains, Bihar, Orissa, Bengal and erstwhile central provinces. Recently, M. Oommachan & K. V. Billore, (1971) have reported it from Bhopal, M.P. The species has also been reported from Tropical Africa and Madagascar, from where probably it was introduced into the Indian subcontinent.

ACKNOWLEDGEMENTS

The authors are grateful to the authorities of the Baria Forest Division for facilities during the tours, and the research staff, Systematic Botany Branch, F.R.I. & Colleges, Dehra Dun, for their kind co-operation. We are also thankful to Prof. P. V. Bole and Dr. S. D. Sabnis for critically going through the manuscript.

This research has been financed in part by a grant made by the United States Department of Agriculture under PL-480.

TAXONOMY LABORATORY,
DEPARTMENT OF BOTANY,
THE M. S. UNIVERSITY OF BARODA,
BARODA-2,
September 16, 1972.

S. J. BEDI
D. N. THAKER

21. NOTES ON THE IDENTITY AND NOMENCLATURE OF *VENTILAGO BOMBAIENSIS* DAIZ.

In the course of revising the Indian species of the Rhamnaceae, I had an opportunity to go through 'Studies in the Rhamnaceae, III—A Taxonomic Revision of Indian Ventilagineae' by Banerjee & Mukerjee (1970), and do find myself under the necessity to dissent from their opinion with regard to the identity and nomenclature of

Ventilago bombaiensis Dalz. Santapau's (1944, 1953) views and findings and that of (1968, 1970) are now endorsed as in all probability correct.

Banerjee & Mukerjee (1970) have stated that, ' *V. bombaiensis* Dalz. appears to be a species of *Smythea* and not of *Ventilago* and hence it has been transferred to the genus as a *comb. nov.* : *Smythea bombaiensis* (Dalz.) S. P. Ban. et P. K. Mukh. .... The confusion in the identity of *S. bombaiensis* arose due to the non-availability of mature fruits .... '

Santapau (1953) listed this species in his FLORA OF KHANDALA ON THE WESTERN GHATS OF INDIA. Santapau spent twelve years in the exploration of Khandala where this pretty climbing shrub is very common on the slopes below Echo point at an altitude of about 500 m and common also below Elphinstone point about half way down to the ravine. In the fruiting season—February to March, fruits may be seen scattered over large tracts of forests.

All Khandala specimens of Santapau were checked against the actual types, when these were available in London, or with the best specimens in Kew Gardens, British Museum of Natural History, London, and the Linnean Society.

According to the note on ' *Ventilago bombaiensis* Dalz. ' by Santapau (1944), there seemed to be a good deal of confusion regarding the identity of this plant, due principally to the fact that the fruit was not seen or was not fully described till Santapau prepared his note. Both Cooke I : 239 and Talbot *For. Fl.* I : 293 confessed that they had not seen the fruit. Gamble gave a very meagre description of the fruit.

Santapau observed the plant and collected the material on several occasions from Khandala over and above basing his findings on the abundant Herbarium sheets of the Blatter Herbarium. *Even ripe fruits and seeds were observed in the field* !

I, therefore, feel strongly that there should not be any confusion whatsoever in the identity of *V. bombaiensis* Dalz. The generic transfer case of 1970 in *Indian For.* 96 : 214 with regard to *Smythea bombaiensis* (Dalz.) S. P. Ban. et P. K. Mukh. should be relegated to the synonymy of a distinct taxon *V. bombaiensis* Dalz.

GENERAL EDUCATION CENTRE,
MAHARAJA SAYAJI RAO UNIVERSITY OF BARODA,
BARODA-2,
April 26, 1973.

G. M. OZA

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TALBOT, W. A. (1909-11): Forest Flora of the Bombay Presidency and Sind, Poona. **1**: 1909; **2**: 1911.

22. *VALERIANELLA LOCUSTA* (LINN.) LATERRADE—A NEW RECORD FOR INDIA

The unspectacular genus *Valerianella* can easily be missed in the field. *Valerianella locusta* is, therefore, presented as a new record for India, in the Kashmir valley.

The authors owe a debt of gratitude to Dr. I. A. Linczevski of the Komarov Botanical Institute, Leningrad, U.S.S.R., for confirming the identity of the species and for sending the literature on the subject. The authors are also grateful to Mr. B. L. Burtt, F.L.S., Royal Botanic Garden, Edinburgh, for his help in making the literature available for the present study.

Valerianella locusta (Linn.) Laterrade, Fl. Bordelaise (ed. 2) 93, 1821; Betcke, Animadv. bot. Valer. 10, 1826; Linczevski in Fl. U.S.S.R. 23; 663, t. 34, f. 1, 1958; Coode in Notes Royal bot. Gdn. Edin. 27(3): 235, f. 4(1-4), 1967.

V. olitoria Pollich, Hist. Pl. Palat. 1: 30, 1776; DC. Prodr. 4: 625, 1830; Krok in Vet.-Akad. Handl. Stockh. 5(1): 88, 1864; Boiss. Fl. Or. 3: 104, 1875.

Valeriana locusta Linn. Sp. Pl. 33, 1753, cum var. *olitoria.*

Valerianella locusta Linn. Fl. Suecica (ed. 2) 12, 1755.

V. olitoria Willd. Sp. pl. 1: 184, 1798.

Fedia olitoria Vahl, Enum. 2: 19, 1806.

F. striata Stev. in Mém. Soc. Nat. Mosc. 2: 177, 1809.

Description: Erect annual herb up to 40 cm tall; stem dichotomously branched, almost glabrous to slightly puberulous, more prominently at the nodes, slightly ridged. Basal leaves spathulate to nearly oblanceolate, prominently narrowed towards base, almost entire, 3-6 cm long, up to 15 mm broad; stem leaves opposite, lanceolate-oblong, entire with few distant teeth near base, sessile, upto 4 cm long, apex acute or subobtuse. Flowers on long peduncles forming 6-12 mm broad flat topped cymes, 1·5-2 mm across, pale lilac. Bracts oblong, 3-5 mm long, ciliate especially on margins. Calyx indistinct, single toothed. Corolla tube nearly 2 mm long, lobes 5, ovate-oblong. Stamens 3, shortly exserted. Style equalling the stamens in length, stigma capitate and trifid. Fruit somewhat orbicular to ovoid with short apical tooth, 2·1-2·5 mm long, 4·8-2 mm broad, three celled, two cells barren and as large as the third fertile one ; fertile cell single seeded with a corky mass on the back, sterile cells separated by a membraneous, partition, externally by a shallow groove ; fruit pubescent more prominently over the fertile side.

Distribution in Jammu and Kashmir State, India :

Orchards near Kashmir University Campus, Srinagar (*Gurcharan Singh* 665b, dated 15-v-1970, alt. 1590 m) ; Emporium Garden, Srinagar (Gurucharan Singh 4212, dated 5-vi-1972, alt. 1590 m). Sheets deposited in the herbarium of Botany Department, Kashmir University, Srinagar.

Geographical distribution :

INDEX KEWENSIS gives Europe, Oriens as the home of this plant. Europe, U.S.S.R., Turkey, Iran.

GENERAL EDUCATION CENTRE,
M. S. UNIVERSITY OF BARODA,
BARODA-390002.
G. M. OZA

DEPARTMENT OF BOTANY,
KASHMIR UNIVERSITY,
SRINAGAR,
GURUCHARAN SINGH

April 10, 1973.

23. NOTES ON SOME INTERESTING PLANTS FROM SOUTH INDIA—II

Alloteropsis semialata (R. Br.) Hitchc. var. **viatica** (Griff.) Ellis et Karthik. stat. et comb. nov. *Aira viatica* Griff. pl. Asiat. 3 : 54. 1851. *Axonopus semialatus* (R. Br.) Hook. f. Fl. Brit. Ind. 7 : 64. 1896, *pp.*

The collection of this interesting grass from Kozhikode (Calicut) Dt., Kerala, records its occurrence for the first time from peninsular India ; hitherto it has been recorded only from Assam and Ceylon. Since Fischer (1934), and Bor (1960), working on Indian grasses, have not indicated its occurrence from this part of India, nor are there earlier collections in MH, it probably is a new entrant.

Bor (l.c.) has indicated that an interesting variant of *Alloteropsis semialata* with a broad membranous wing on the margins of the upper glume is occasionally found, and tentatively advocates for its recognition even '. . . as the colour variant var. *eckloniana* ' ; this has been previously named *Aira viatica* by Griffith.

Studies of the plants from Ceylon, Assam, Khasia and Jaintia Hills, Manipur and Kerala reveal an interesting array of characters with specimens having the upper glumes winged, and some without. It is remarkable that no intermediate forms have been observed regarding this character. Thus, it is possible to separate the two varieties, viz., *semialata* and *viatica* depending on this character. It has not been the same with the purple bands on the lower lemma ; their presence is seen as indistinct purple dots even in those not having the bands, indicating the stability of the character.

From the characters given in the following table, it seems to appear that emphasis on the colour character cannot be relied on and that eventually var. *eckloniana* Hubbard may have to be merged with the species proper.

Herbarium specimen	Date	Locality	Upper glume	Lower lemma
1. Collector and date not given (Acc. No.: MH 88903)		Ceylon	entire	purple bands present
2. *M.A. Lawson* 20	1882	C.P. Ceylon	winged	purple bands present though not distinct.
3. *N.L. Bor, s.n.* (Acc. No: ASSAM 34014)	Dec. 1936	Assam	entire	purple bands present
4. *S.R. Sharma* 20166	28-6-1938	Lawlyngodh, Khasia& Jaintia Hills, Assam	winged	purple bands present
5. *Shri Rangdar* 12751 (confirmed by N.L. Bor)	20-6-1935	Swift falls, Khasia & Jaintia Hills, Assam	winged	purple bands present
6. *P.C. Kanjilal* 10389 (confirmed by N.L. Bor)	28-4-1930	Swift falls, Khasia & Jaintia Hills, Assam	winged	Purple bands present
7. *George Watt* 6786	Apr. 1882	Khongin, Manipur	entire	purple bands present
8. *J. L. Ellis SC* 24089	12-5-1965	Pavagada, Kozhikode Dt., Kerala	winged	obscure purple bands present.

Mikania cordata (Burm. f.) B. L. Robinson in Contrib. Gray Herb. CIV. 65. 1934 ; Koster in Blumea 1 : 504. 1935 ; Bhaskaran Nair in Sci. & Cult. 34 : 254-255. 1968. *Eupatorium cordatum* Burm, f. Fl. Ind. 176. 1768. *Mikania scandens* C.B. Cl. Comp. Ind. 35. 1876 ; Hook. f. Fl. Brit. Ind. 3 : 244. 1882. *M. cordata* forma *undulata*, Koster, l.c. 506 ; forma *dentata* Koster, l.c. 508.

Josephine Koster (1935) has given a critical and detailed description of this plant, describing 3 forms under the species. The differentiating characters given by her are as follows :

forma *cordata*	forma *undulata* Koster	forma *dentata* Koster
1. Leaves entire, cordate-ovate or cordate ; auricles rounded.	1. Leaves crenate or undulate, shortly mucronulate.	Leaves angularly cordate or hastately cordate, shortly dentate, acute, mucronate, apically tapering.

Hooker f. (1881) gives the characters of leaves of *M. cordata* as ' ovate-acute or acuminate, base rounded, cordate or truncate, crenate or angled, sometimes villous beneath, . . . '. Recently, Bhaskaran Nair (1968) has reported the occurrence of *M. cordata* near Kottayam, Kerala, having leaves ' submembranous, broadly triangular, palmately reticulate, wavy . . . ' From the accompanying figures given of the leaves, they seem to be undulate and irregular on the margin and not dentate or angular. The leaves of the plants collected by us in 1967 from Chendanathode, Cannanore Dt., Kerala, are dentate and deeply dentate-cordate. In fact, the leaves of plants collected agree more or less with both the forma *undulata* and forma *dentata*.

As this plant comes under the category of a weed, it is natural for it to have aggressive type of propagation and spreading, adopting itself to various kinds of environment, showing variability in the shape of leaves, etc. To segregate a number of forms to accommodate all the variations seen in these types of plants cannot, therefore, be taken too seriously. The recent collections of Kottayam and Chendanathode—places separated by about 280 km are the indications of the variations. It is, therefore, concluded that the forms of Koster under *M. cordata* may not stand ; they have to be taken as variations of the typical. It has been treated so in this note.

It is, however, interesting to note that the plant is gaining ground in south India and may become yet another weed to invade the western ghats. All possible steps should be taken before it becomes a serious pest.

Exsicc. : Chendanathode, Cannanore Dt., Kerala, Dec. 1967, *Ellis SC* 29547.

Eryngium foetidum Linn. Sp. Pl. 1 : 232. 1753 ; Wolff in Engler's Das Pflanzenr. iv : 228. 203. 1913 ; Buwalda in Blumea 2 : 164. 1936 and in Flora Males. serr. I, 4 (2) : 126. 1949.

This strongly scented plant is hitherto known in India only from Assam (Kanjilal *et al.* 1938) and Bengal (Mukerjee 1965). The present collection from Chendanathode, Cannanore Dt., Kerala, is a new record for peninsular India.

Herman Wolff (1913) and recently Buwalda (1949) have dealt with this plant in detail. As the plant is poorly known in India, it is thought that a description of the same will be of use.

Herbs about 30 cm high, strongly scented ; roots long and fusiform ; stems monochasially repeatedly branched, prominently grooved, glabrous. *Leaves* radical, rosette, alternate at base, elliptic-obovate, spathulate, prominently spinous dentate, petiole winged, sheathing ; *nerves* dichotomous, prominent near the margin, in the dentature and on the edge, midrib rather broad and diffused. *Inflorescence* in cylindric heads at ends of branches, subtended at base by strongly dentate bracts, about 1 cm long. *Bracts* rosette, elliptic-obovate, often long-spinously lobate, glabrous, strongly 3-5 parallel-veined, marginal edge thick, ± 2·5 × 1·0 cm lowermost bract foliar. *Bracteoles* small, scarious-margined, amplexicaul. *Calyx* 5-lobed ; lobes lanceolate, scarious-margined, persistent. *Petals* 5, greenish white, elliptic, inflexed with a central prominent thin membrane within, deeply grooved without, caducous. *Stamens* 5, recurved in buds ; anthers 3-celled, dorsifixed, vertically dehiscing. *Ovary* subglobose, rugose ; styles 2, linear. *Cremocarp* warted, glabrous.

Exsicc. : Chendanathode, Cannanore Dt., Kerala, 3-11-1965, *Ellis SC* 26414.

4. **Ichnanthus vicinus** (F. M. Bail.) Merr. in Enum. Philipp. Fl. Pl. 1 : 70. 1923 ; Bor, Grasses 314. 1960. *Panicum vicinum* F. M. Bail. Syn. Queens. Fl. Suppll. 3 : 82. 1890. *Ichnanthus pallens* Hook. f. Fl. Brit. Ind. 7 : 60. 1896 (non Munro, 1861).

This grass has been collected so far only from the hills of north-east India and from Ceylon, and now for the first time it is recorded from peninsular India.

It grows densely under shade as a forest undergrowth, and at first sight it can be mistaken for a *Panicum*. But the peculiar twisting of the upper lemma through 90°, presence of lateral appendages at the base, and the sub-aristate lower glume immediately separate it from that genus.

This plant is rather poorly known in India and, therefore, a description is appended to facilitate identification.

Herb many branched, perennial, rooting at nodes ; *culms* striate, sparsely hairy ; *nodes* puberulous. *Leafblade* 1·5-10 × 0·8-2·75 cm, ovate to ovate-lanceolate, cordate, sub-amplexicaul, setose from tubercles present at base, pilose below when young, glabrous at length, scaberulous on the margin, scabrid on the nerves and sparsely pilose above ; *leaf sheath* 0·9-4·8 cm long, striate, sparsely pilose, densely hairy along the margins ; *ligule* a fringe of hairs about 2 mm long. *Inflorescence* lax 2·19 × 0·5-5 cm ; *peduncle* 1-20 cm long, main rachis subterate, striate, sparsely pilose ; secondary branches 0·9-8 cm long. *Spikelets* 4-5 × 2-4 mm, elliptic-ovate, pedicelled; *pedicels* 1-5 mm long, capillary. angled scabrid ; *florets* 2, dissimilar ; lower male or barren, *upper* hermaphrodite ; *lower glume* 3·5 × 1 mm, green with hyaline margin, keeled, ovate-lanceolate, very shortly aristate, 3-nerved, nerves scabrid ; *upper glume* 4-5 × 1·5 mm, ovate-lanceolate, acuminate, 5-nerved, nerves scabrid ; *lower lemma* 3·5-4 × 1·5-2 mm, ovate, acute, 5-nerved, nerves scaberulous, 2-keeled, margins hyaline ; *upper lemma* 2-2·5 × 1-1·25 mm, oblong, acute, coriaceous, smooth, shining, margins involute ; *appendages* 2, lateral, hyaline ; *lower palea* 2·5-3 × 0·5-·75 mm, hyaline, elliptic-lanceolate, acute, 2-keeled, shortly ciliate ; *upper palea* 1·75-2 × 1·5-1·75 mm, margins involute, thinly coriaceous, smooth, shining ; *lodicules* 2, linear *Stamens* 3. *Ovary* small, styles 2 ; stigmas feathery.

Exsicc. : INDIA : Meghalaya (Assam) *J. D. Hooker & T. Thomson* s.n. (Acc. No. : MH 87651). Tamil Nadu (Madras)—Nilgiri Dt., Santhi Estate, Ouchterlony valley, Gudalur, 29-1-1971, *J. L. Ellis SC* 37749. Andhra Pradesh—Visakhapatnam Dt., Way to Gudem, Chintapalli, 900 m, 13-11-1970, *J. L. Ellis SC* 37135. CEYLON : C.P., no definite locality, 1882, *M.A. Lawson* 61.

ACKNOWLEDGEMENTS

We are thankful to the Director, Botanical Survey of India, Calcutta, for his interest and facilities extended and to Dr. N. L. Bor, England, for examining the grass sent and giving his valuable opinion on the varieties of *Alloteropsis semialata*.

J. L. ELLIS
S. KARTHIKEYAN

SOUTHERN CIRCLE,
BOTANICAL SURVEY OF INDIA,
COIMBATORE-2,
March 2, 1972.

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24. A NOTE ON THE DISTRIBUTION OF SOME PLANTS IN CHANDRAPUR DISTRICT (MAHARASHTRA STATE)

The district of Chandrapur in Maharashtra State lies between 78°51′-81° north latitude and 20°50′-18°40′ east longitude, bordered by the States of Madhya Pradesh on the eastern side and Andhra Pradesh on the western side.

In the course of a few botanical explorations during the years 1969-71, a few plants have been reported for the first time from this district which have not been earlier recorded by Cooke (1901-1908) or Haines (1916) which serve as a new record or an extension of their known distribution.

All the specimens are deposited in the Regional Herbarium of the Botanical Survey of India, Western Circle, Poona (*BSI*).

MELASTOMATACEAE

Osbeckia zeylanica Willd. sp. pl. ii : 300, 1799 ; Clarke in Fl. Brit. India 2 : 516, 1879.

An erect herb. Leaves oblong, lanceolate. Flowers purple mauve. Calyx tube with stellate bristles. Anthers beaked. Fruits ovoid, oblong.

Flowers & fruits : October-November. *Locality :* Repanpalli, *Malhotra* 123331 ; Taroba, *Malhotra* 122732.

Herb growing on moist sandy soils. Common in peninsular India and the present record from Chandrapur district is an extension of its distribution further north. This is the first report of the plant from Maharashtra State.

RUBIACEAE

Dentella serpyllifolia Wall. ex Airy Shaw in Kew Bull. 1932 : 289, 1932. *D. repens* sensu Hook. f. Fl. Brit. India 3 : 42, 1880.

Herb. Leaves subsessile, oblong elliptic, glabrous. Flowers subsessile. Calyx membranous, corolla white. Capsules glabrous.

Flowers & fruits : April-May. *Locality :* Kolsa, *Malhotra* 135268.

Herb growing on sandy soils. Distributed in the States of Andhra Pradesh, Bihar and Orissa etc. The present record from Chandrapur district indicates its specific occurrence in Maharashtra State.

GENTIANACEAE

Canscora sessiliflora Roem. & Sch. Syst. iii. Monat. 230, 1818 ; Clarke in Fl. Brit. India 4 : 104 1883 ; Gamble in Fl. Pres. Madras 618, 1923.

An erect herb. Leaves subacute sessible. Flowers pink. Calyx not winged. Capsules oblong.

Flowers & fruits : October-November. *Locality :* Aksapur, *Malhotra* 123698.

Herb. Rare, growing on moist clayey soils.

Earlier recorded only from southern India and now reported for the first time from Maharashtra State.

POACEAE

Dimeria connivens Hack in DC. Monogr. Phan. 6 : 689, 1889 ; Hook. in Fl. Brit. India 7 : 104, 1897 ; Bor, Grasses of Burma, Ceylon, India and Pakistan, 140, 1960.

Annual. Spikelets subsessile, sparsely ciliate. Upper glume narrowly winged all along the keel.

Flowers & fruits : October-November. *Locality :* Ghot, *Malhotra* 123156.

Rare on moist gritty soil.

Earlier reported from Bihar and Orissa only. However, it is interesting to note its occurrence in Chandrapur district. There is every possibility that the species may extend its distribution to adjoining states of Madhya Pradesh and Andhra Pradesh also.

Mnesithea laevis (Retz.) Kunth, Rev. Gram. 1 : 154, 1829 ; Bor loc. cit. 197, 1960. *Rottboellia perforata* Roxb ; Hook. loc. cit. 158, 1897.

Annual. Spikes slightly exerted, pedicelled, spikelets suppressed. Lower glume of the sessile spikelet oblong with a slightly oblique apex.

Flowers & fruits: September-October. *Locality:* Taroba, *Malhotra* 122835.

Rare on moist gritty soil.

Though reportedly common in many States of India it has not been reported from Maharashtra proper and the present record is an extension of its known distribution.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. K. Subramanyam, Director, Botanical Survey of India, Calcutta for providing the necessary facilities in carrying out this work.

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE, POONA-1,
November 18, 1972.

S. K. MALHOTRA
S. MOORTHY

REFERENCES

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ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1972-73

Executive Committee

President

Mr. Sumant Moolgaokar

Vice-Presidents

Dr. Sálim Ali, D.Sc., F.N.A.
Mr. R. E. Hawkins
Mr. G. V. Bedekar, I.C.S. (Retd.), J.P.

Hon. Secretary

Mr. Zafar Futehally

Hon. Treasurer

Mr. J. D. Kapadia, I.C.S. (Retd.)

Member

Secretary, Ministry of Education, Govt. of India

ex-officio

Elected Members

Dr. S. R. Amladi, M.D.
Prof. P. V. Bole
Dr. E. B. Fanibunda, F.D.S.R.C.S. (Eng.), F.R.P.S.
Dr. C. V. Kulkarni, M.Sc., Ph.D. (*Jt. Hon. Secretary*)
Dr. A. N. D. Nanavati, M.D.
Mr. D. J. Panday
Mr. B. B. Paymaster, I.C.S. (Retd.)
Mr. G. S. Ranganathan
Mr. D. E. Reuben, I.C.S. (Retd.)
Mr. Sandip Thakore

Advisory Committee

Mr. H. G. Acharya	*Ahmedabad*
Mrs. Jamal Ara	*Ranchi*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Mr. S. Chaudhuri	*Calcutta*
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Dr. A. P. Kapur	*Calcutta*
Mr. M. Krishnan	*Madras*
Mr. Duleep Matthai	*New Delhi*
Mr. Ranjit Sinh, I.A.S.	*New Delhi*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1972

MEMBERSHIP

During the year 158 new members were enrolled as against 71 resignations and death. The slight increase in membership is welcome but we have a long way to go. 157 are in arrears since 1971.

Comparative figures for three years are given below :

	1970	1971	1972
Life Members	174	181	187
Ordinary Members	703	780	801
Forest Department Nominees ..	78	80	89
Student Members	5	5	9
Honorary Members	3	3	3
	963	1049	1089

THE SOCIETY'S PUBLICATIONS

Journal : Three issues of the Journal were published during the year: Vol. 68, No. 3 and Nos. 1 & 2 of Volume 69.

The articles covered a wide range of subjects with special emphasis on ecology, behaviour and taxonomy of Indian fauna and taxonomy and regional lists of the flora. Special mention needs to be made of the report by Mr. Krishnan on the Mammals of Peninsular India which started as a serial in Vol. 68(3) and will be completed in Vol. 69(3). As we reported last year the financial assistance received from the Seth Purushottamdas Diwaliba Trust enabled us to print all the excellent photographs submitted by Mr. Krishnan.

The editors regret that in spite of their best efforts it has not been possible to publish the Journal issue within the stipulated publication dates. This is largely due to delay in printing. The Journal has been printed by the Diocesan Press at Madras since 1926, and at rates much lower than those obtained at Bombay. We will continue our efforts to publish in time.

Books : During the year the following sales were made :

BOOK OF INDIAN BIRDS (8th & 9th Editions) ..	943	copies
BOOK OF INDIAN ANIMALS (3rd Edition) ..	407	,,
PICTURE POST CARDS ..	127	,,
SNAKE CHARTS ..	122	,,

The 9th edition of the Bird Book appeared during the year. The text and plates have been re-arranged to bring the book in step with recent classification. We are indebted to Lady Peng McNeice for guaranteeing overdraft facilities for the publication of the book.

CONSERVATION

The Society continued to take a leading part in the Conservation movement in the country through its representatives on the State and Central Wild Life Boards, and through its members on the International Union for Conservation of Nature and Natural Resources, the World Wildlife Fund and the International Council for Bird Preservation.

The Maharashtra State Forest Department has been persuaded to establish a floral sanctuary at Khandala to perpetuate the memory of the late Fr. H. Santapau, a former Vice-President of the Society, and one of India's foremost botanists.

Efforts are being made to have a bird sanctuary in Mahim Creek within Bombay City, a haunt of waders during the migratory season. This proposal has received considerable support from many quarters and we hope that the various departments concerned will take the necessary steps to save the area from further degradation.

The Central Government has been approached by the IUCN to request the Tamil Nadu Government to declare the Kalakkadu forest in South Tirunelveli Dist. a wilderness area. The area had been earlier surveyed by the Society's staff and the action taken by the IUCN is the result of the Society's recommendations. The Society has been in touch with other organisations at Bombay who are concerned with the deteriorating environment and some meetings were held to stimulate officials and others to make an attempt to improve the situation.

FIELD SURVEYS

Two field collection trips were arranged during the year, one to Narcondam Island under the overall supervision of Mr. H. Abdulali. The field party spent a month on the Island and brought back an interesting collection of various forms including two live specimens of the rare Narcondam Hornbill.

The Goa area was surveyed by a field party led by Dr. Sálim Ali. A representative collection of birds was made but more were caught in mist nets, examined and released after recording data.

RESEARCH STUDIES

Gir Project : Field work under the project ended in August when the Researchers returned to Bombay with the project equipment. Further field activity was curtailed by the lack of funds. A symposium on the achievements of the Gir Project was held in November at New Delhi.

The Society continued to receive offers of collaborative studies on Indian Fauna. Some on which the Society plans to collaborate or has offered assistance are listed below :

(1) Studies on the Langurs and Macaques on the Peninsula by a research team from Kyoto University, Japan.
(2) A study of the Lion-tailed Macaque by the Rockefeller University, New York.
(3) The Population of Crocodiles in India—New York Zoological Society.
(4) The ecology of the Wild Dog.
(5) The biology of Whistling Teals of the genus *Dendrocygna.*

Advice and assistance was given to the Government of India in the preparation of a plan for an ecological station at Bharatpur Sanctuary. Assistance was made available to Dr. Sibley of Yale University for the collection of egg yolk of birds.

University Department : The Society is affiliated to the Bombay University for research leading to the degree of Ph.D. in Field Ornithology and M.Sc. in Field Ornithology, Field Mammalogy and Field Herpetology. During the year, Mr. D. N. Mathew was awarded the degree of Ph.D. in Field Ornithology. The subject of the thesis was ' Ecology of the Baya and comparative feeding habits of certain species of Indian Birds associated with agriculture '. He was the first to receive the degree through Bombay Natural History Society.

Bird Migration

The Bombay Natural History Society's bird ringing project under the direction of Dr. Sálim Ali has so far ringed 2,70,294 birds belonging to both migratory and non-migratory species. The total number of recoveries to date amount to 3175 and these have been mainly from Russia. One result of these bird migratory studies has been that bird populations from almost all biotopes in the Sub-continent have been sampled. The success of the scheme has been due largely to the co-operation between the Scientists of three countries : India, United States and Russia. The Bird Banding Scheme has also played a significant part in arousing an interest in our Avifauna in both official and non-official circles.

Local Activities

During the year members resident in Bombay had the opportunity of taking part in field activities, lectures and exhibitions organised by the Society.

Leopard Study efforts were made by a small group of members to obtain information and to draw to baits, leopards living in the Borivli National Park near Bombay. Baits were taken twice and leopards seen on several occasions. The study group is supported by funds received from World Wildlife-India and Fauna Preservation Society, U.K., and is continuing its activities.

Nature Walks were organised at Borivli National Park for bird watching and study of the vegetation at different times of the year.

Other Activities : An attempt was made to census the population of crows in Bombay City and some interesting data was obtained.

Meetings/Exhibitions

January : Dr. James Karr spoke on ' Studies of Tropical Forest Bird Communities '.

February : Mr. M. Krishnan spoke on 'Wild Life Photography '.

March : Dr. C. V. Kulkarni spoke on 'Fishes and Fisheries '.

April : Mr. Christian Zuber spoke and showed his film on ' Galapagos Wildlife Paradise '.
An exhibition of Sea Shells from the collection of Mr. A. R. Bhagat.

May : Prof. Carl Gans spoke on ' Locomotion in Snakes '.

July : An exhibition of Snakes from the collection of Mr. Romulus Whitaker.

August : Mr. S. A. Hussain spoke on ' Natural History of Narcondam '.
Mr. P. D. Stracey spoke on ' Wildlife Conservation in Africa '.
Mr. S. P. Shahi spoke on ' Wildlife Photography '.

September : Dr. S. Dillon Ripley spoke on ' Ecological studies in India '.

October : Discussion on ' Some Aspects of the Bombay Environment '.

November : Mr. Zafar Futehally spoke on ' National Parks '.
Dr. D. R. Smith spoke on ' Rangeland and Wildlife Resources '.
The Orchid Club held a show of exotic orchids.
Discussion on ' Some Aspects of the Bombay Environment '.

It will be recalled that at the last Annual General Meeting it was decided that whenever non-members of the Society were also present an appeal should be made to them to join the Society. The procedure occasionally leads to embarrassment particularly when small discussion meetings are held. The Committee therefore decided to have a board placed outside the auditorium with the message 'We need more members, please pick up an application form'. Apart from this, whenever appropriate, a personal appeal continues to be made.

GRANTS & DONATION

The Society acknowledges with gratitude the following grants received for specific purposes:

Rs. 40,000	from the Government of India for manufacture of Cabinets to house the collection.
Rs. 10,000	from Dr. S. D. Ripley for field work.
Rs. 3,000	from Dr. Sálim Ali towards expenses of the Goa Field Survey.
Rs. 3,500	from Dr. Sálim Ali as donation to the Sálim Ali/Loke Ornithological Research Fund.
Rs. 500	from Dr. (Miss) Hamida Saiduzzafar.

RESEARCH & FIELD WORKS FUNDS

Sálim Ali/Loke Ornithological Research Fund:

The Corpus of the fund amounts to Rs. 1,65,636.52.

Expenses during the year were Rs. 6666.33 and Rs. 7822.26 is available for distribution. Two awards were made during the year.

Charles McCann Vertebrate Zoology Field Work Fund:

The assets of the fund totalled Rs. 11,936.10 at the end of the year. Payments were made from the fund towards the cost of the Narcondam Survey trip and other expenditure (Rs. 2462.45).

Col. Burton Field Work Fund:

From the interest received and accrued (Rs. 1454.55) Rs. 503.39 was used towards expenses connected with Nature Walks at Borivli National Park.

Fauna Preservation Society Membership Funds:

At the end of the year the assets of the fund amounted to Rs. 3771.05 after payment of grants made by the Fauna Preservation Society for field work in India. The following grants were made:

Rs. 1,000 to the Leopard Study Group of the Society.

SÁLIM ALI 75TH BIRTHDAY FUND

To honour Dr. Sálim Ali on his 75th Birthday a Committee of members was formed on the initiative of Yuvraj Shri Shivrajkumar and Mr. R. E. Hawkins and an appeal sent out for contributions so that a purse could be presented to Dr. Sálim Ali. The contributions received from members in India amounted to Rs. 12,585.76 and from well-wishers abroad 662.00 dollars was received. The money collected will be utilised for printing a *Festschrift issue* of the Journal and this volume will contain contributions from some of the leading Ornithologists of the World.

NATURE EDUCATION SCHEME

The activities under the Scheme such as field-trips for children and teachers, talks and guided tours at the Museum, Zoo and the Aquarium, talks at schools for children and teachers were organised throughout the year. Seasonal field-trips to study aquatic life and monsoon plants during monsoon and migratory birds and flowering trees during winter and summer were organised in Bombay and Poona. A newsletter summarising the observations was published in Marathi for restricted circulation.

LIBRARY

During the year 140 books were added to the Library, of which 32 were purchased, 80 were donated and 28 received as review copies for the journal.

ADDITIONS TO THE COLLECTIONS

During the year 339 specimens were received at the Sceiety.

Mammals	.. 43
Birds	.. 184
Reptiles	.. 96
Amphibians	.. 16

REVENUE AND ACCOUNTS

The financial situation of the Society continued to be difficult, but the year's operation showed a small surplus Rs. 5518.25 as against a deficit of Rs. 11,541 last year.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the staff in the entire activities of the Society.

ACKNOWLEDGEMENTS

Committee's thanks are due to Mr. M. J. Dickins who looked after the Society's affairs in the U.K., and to the members and others who gave help in its field projects and other activities.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950
SCHEDULE VIII [VIDE RULE 17(1)]

BALANCE SHEET AS AT 31 *DECEMBER*, 1972

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Trust Funds or Corpus :			*Immovable Properties :*		
Life Membership Fund :			*Motor Cars and Motor Cycle :*		
Balance as per last Balance Sheet ..	65,422·26		Balance as per last Balance Sheet ..	30,737·99	
Add : Amount received during the year	4,740·00		*Less :* Depreciation during the year ..	6,147·60	
		70,162·26			24,590·39
			Furniture, Fixture and Equipment :		
Fixed Assets Fund :			Balance as per last Balance Sheet ..	41,131·07	
Balance as per last Balance Sheet (including a donation of Rs. 100 received up-to-date) ..	71,969·06		*Less :* Depreciation during the year ..	5,141·38	
					35,989·69
Less : Transferred to Income and Expenditure Account on account of Depreciation for the year ..	11,288·98		*Investments:* (At cost) Quoted— 12 Ordinary Shares of Rs. 125 each of Ahmedabad Mfg. and Calico Printing Co. Ltd., fully paid (Market Value Rs. 4,488).		
		60,680·08	50, 8% Convertible Bonds each of Rs. 100 of Ahmedabad Mfg. and Calico Printing Co. Ltd., fully paid.		
General Reserve Fund : Balance as per last Balance Sheet ..		34,015·40	202, 8% Redeemable Bonds each of Rs. 116 of Ahmedabad Mfg. and Calico Printing Co. Ltd. fully paid ..	14,210·00	
Carried forward ..		1,64,857·74	Carried forward ..	14,210·00	60,580·08

BALANCE SHEET AS AT 31 *DECEMBER*, 1972—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		1,64,857·74	Brought forward ..		60,580·08
Building Fund: Balance as per last Balance Sheet ..		9,244·68	*Investments*: (At cost) Brought forward	14,210·00	
			Government Securities : 3% Conversion Loan 1946/86 of the face value of Rs. 25,000. (Market value Rs. 15,000·00) ..	25,000·00	
Publication Fund : Balance as per last Balance Sheet ..		30,725·00	5½% Government of India Loan 2,000 of the face value of Rs. 2,000 (Market value Rs. 1952·00) ..	2,000·00	
Other Earmarked Funds : (As per Schedule 'A') ..		2,74,766·73		41,210·00	
Provision for Capital Losses : Balance as per last Balance Sheet ..		4,528·38	*Unquoted :* 12 Year National Defence Certificates of the face value of Rs. 3,000 ..	3,000·00	
Provision for Depreciation on Investments : Balance as per last Balance Sheet ..		6,801·25	*Deposit with :* M/s. Indian Dyestuff Industries Ltd., Bombay	1,25,000·00	1,69,210·00
			Loans : (Unsecured, considered good) Loan Scholarships ..	—	
			Other Loans (to staff) ..	130·00	130·00
Carried forward ..		4,90,923·78	Carried forward ..		2,29,920·08

BALANCE SHEET AS AT 31 *DECEMBER*, 1972—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.
Brought forward ..		4,90,923·78
Liabilities :		
For Expenses	1,21,206·91	
,, Advance Subscription and other Advances	3,636·42	
,, Sundry Credit Balances ..	32,433·84	1,57,277·17
(*Note :* * The abovesaid shares/bonds have been allotted in exchange of 95 ordinary shares and 107-A shares (equity) of Bank of India, which the Society had been holding.)		
Carried forward ..		6,48,200·95

ASSETS	Rs. P.	Rs. P.
Brought forward ..		2,29,920·08
Advances :		
To Trustees ..	—	
,, Employees (for camp expenses).	2,615·39	
,, Others ..	139·67	2,755·06
Stocks : (At cost)		
Publications	1,04,808·99	
Process cost of publications ..	3,325.74	1,08,134·73
Income Outstanding :		
Rent	—	
Interest Accrued	10,419.58	
Income-tax (refundable for Assessment year 1972-73)	89·00	
Other Income:		
Supplies and Services	32,877·97	
Indian National Science Academy ..	3,000·00	46,386·55
Cash and Bank Balances :		
(*a*) In Current Account with :		
National & Grindlays Bank Ltd., Bombay ..	84,082.64	
National & Grindlays Bank Ltd., London (£771·06 @ Rs. 18) ..	13,879·08	
Chartered Bank, Bombay ..	26,206·70	
Carried forward ..	1,24,168·42	3,87,196·42

BALANCE SHEET AS AT 31 *DECEMBER*, 1972—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward ..		6,48,200·95	Brought forward ..	1,24,168·42	3,87,196·42
Notes:			*Cash and Bank Balances*: (Contd.)		
(1) The Membership Subscriptions are taken into account on cash basis. The amount due as at 31st December 1972 from members is not ascertainable.			*In Savings Account with*: National and Grindlays Bank Ltd., Bombay	323·54	
(2) All expenses incurred on the various projects and activities for which specific grants and donations are received have been directly charged to the respective funds account as shown in the schedule annexed to the Balance Sheet.			(*b*) *In Fixed Deposit with*: Bank of India, Bombay (consisting of Rs. 36,000 of Sálim Ali / Loke Wan tho Ornithological Research Fund and Rs. 3,000 for Col. Burton's Nature Conservation Fund) ..	39,000·00	
			Chartered Bank, Bombay ..	60,000·00	2,23,491·96
			Income and Expenditure Account:		
			Balance as per last Balance Sheet ..	43,030·82	
			Less: Surplus as per Income and Expenditure Account during the year.	5,518·25	37,512·57
Total ..		6,48,200·95	Total ..		6,48,200·95

As per our report annexed
(Sd.) HABIB & CO.,
Chartered Accountants.

(Sd.) ZAFAR FUTEHALLY,
Honorary Secretary,
Bombay Natural History Society.

(Sd.) J. D. KAPADIA,
Honorary Treasurer,
Bombay Natural History Society.

(Sd.) G. V. BEDEKAR,
Chairman, *Executive Committee*,
Bombay Natural History Society.

The above Balance Sheet to the best of our belief contains a true account of the funds and liabilities and property and assets of the trust as per our report annexed.
Trustees.

BOMBAY, 17*th August* 1973.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE IX [VIDE RULE 17(1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1972

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
To Expenses in respect of properties :			*By Rent :*		
			Accrued	Nil	
			Realised	Nil	
Rates, Taxes & Cesses		Nil			Nil
Repairs and Maintenance ..		Nil	,, *Interest* (Accrued and Realised) (excluding items directly credited to grant accounts)		
Salaries		Nil			
Depreciation (by way of provision or adjustments)		Nil	On Securities	3,374·56	
			Less: Income tax deducted at source	523·00	
				2,851·56	
,, *Expenditure from Grants—Government of Maharashtra :*			On Bank Account (Fixed Deposits) ..	3,757·35	6,608·91
For 1971-72 : Salaries, including Dearness Allowance (per contra) ..	8,937·22		,, *Dividends*	216·00	
			Less: Income tax deducted at source	50·00	166 00
For 1972-73 : Salaries, including Dearness Allowance (per contra) ..	27,188·50		,, *Donations :* In cash	13,064·00	
For 1971-72 : Building Maintenance (per contra)	1,234·35		In kind	Ni	13,064.00
For 1972-73 : Building Maintenance (per contra)	3,675·59	41,035·66	,, *Grants :* *Government of Maharashtra :* For 1971-72 (Expended as per contra)	8,937·22	
			For 1972-73 (Expended as per contra)	27,188·50	
Carried forward ..		41,035·66	Carried forward ..	36,125·72	19,838·91

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1972—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.
Brought forward ..		41,035·66
To Establishment Expenses :		
Salaries including Dearness Allowance	59,738·25	
Society's contribution to Staff Provident Fund	2,733·22	
Postages	3,156·55	
Printing and Stationery (including prospectus printing)	3,395·90	
Advertisements	392·20	
Telephone Charges	1,638·26	
Bank Charges	611·46	
Meeting Expenses	1,578·16	
Conveyance and Travelling Expenses	234·94	
Interest on overdraft	88·12	
Motor Car charges	1,674·85	
		75,241·91
To Audit Fees :		1,000·00
To Miscellaneous Expenses :		
General Charges	1,408·61	
Insurance premium	169·95	
Repairs to Furniture	166·16	
Narcondam Hornbill feeding expenses	222·95	
		1,967·67
Carried forward ..		1,19,245·24

INCOME	Rs. P.	Rs. P.
Brought forward ..	36,125·72	19,838·91
By Grants : (contd.)		
For 1971-72 (Expended as per contra)	1,234·35	
For 1972-73 (Expended as per contra)	3,675·59	
Educational Activity Grant 1972-73	4,000·00	
,, *Government of India:*		
For Journal Publication Expenses for 1972-73	25,000·00	
,, *Indian National Science Academy:*		
For Journal Publication Expenses for 1972-73	3,000·00	
		73,035·66
,, *Income from Other Sources :*		
Membership Subscriptions ..	32,832·40	
Subscribers to Journal (non-Members)	10,790·84	
Student Membership Subscriptions ..	220·00	
Entrance Fees	790·00	
		44,633·24
,, *Publications :*		
Journal Sales (Back Numbers) ..	303·72	
,, *Profit on Sale of Books :*		
Book of Indian Birds	4,263·16	
Book of Indian Animals ..	5,258·66	
Identification of Poisonous Snakes charts	626·50	
Carried forward ..	10,452·04	1,37,507·81

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER*, 1972—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.
Brought forward ..		1,19,245·24
To Amounts Written off :		
(*a*) Bad Debts	23·51	
(*b*) Loan Scholarships	Nil	
(*c*) Irrecoverable Rent	Nil	
(*d*) Other Items	Nil	23·51
,, *Depreciation :*		
On Investments	Nil	
On Furniture and Equipment ..	5,141·38	
On Motor Cars and Auto Cycle ..	6,147·60	11,288·98
,, *Expenditure on Objects of the Trust :*		
(*a*) Religious	Nil	
(*b*) Educational—Journal Expenses	55,549·76	
—Journal Indexes..	9,360·00	64,909·76
Library Account :		
Subscriptions to other Societies ..	1,420·59	
Purchase of books	342·69	
Periodicals and binding charges ..	131·00	
Library & other maintenance ..	185·50	2,079·78
,, *Maintenance of Reference Collections* ..		1,570·49
Excess of Income over Expenditure transferred to Balance Sheet ..		5,518·25
Total ..		2,04,636·01

INCOME	Rs. P.	Rs. P.
Brought forward ..	10,452·04	1,37,507·81
Profit on sale of Books (contd.)		
Picture Post-cards	286·00	
Other Publications	4,308·05	
Nature Calendars & Greeting cards	8,277·03	
	23,323·12	
Add: Profit on packing & forwarding	446·82	23,769·94
By Miscellaneous Receipts : (including Rs. 6,000 compensation from World Wild Life, Regional Office, Bombay, and the balance of Rs. 323·54 being the interest earned in the past, on C.S.I.R. Grant-in-aid Bank account) ..		12,847·13
Administrative fees on handling various project grants during the year, (debited to the respective grants/fund)		10,104·76
Fees for the use of Society's transperencies		9,117·39
,, *Transfers :* From Fixed Assets Fund on account of Depreciation (as per contra) ..		11,288·98
Total ..		2,04,636·01

As per our report annexed.
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY, 17*th August* 1973.

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF THE BALANCE SHEET AS AT 31 *DECEMBER*, 1972

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ refunded during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December 1972 (5 minus 8)* (9)
(1) Field Work Fund ..	289·04	..	..	289·04	201·40	..	201·40	87·64
(2) Staff Welfare Fund ..	2,220·69	1,000 00	..	3,220·69	..	..	..	3,220·69
(3) Dr. Sálim Ali /Loke Wan Tho Ornithological Research Fund	1,61,636·52	4,000·00	..	1,65,636·52	..	..	..	1,65,636·52
(4) Col. Burton's Nature Conservation Fund ..	4,238·05	216·50	..	4,454·55	503·39	..	503·39	3,951·16
(5) Grant from California Academy of Science for Herpetological Survey ..	904·64	..	..	904·64	264·17	..	264·17	640·47
(6) Charles McCann Vertebrate Zoology Field Work Fund (by Shri Humayun Abdulali)	14,398·55	..	..	14,398·55	2,462·45	..	2,462·45	11,936·10
(7) Grant from Seth Purushottamdas Thakurdas and Divaliba Charitable Trust for the publication of Sri M. Krishnan's Ecological Survey of India..	15,014·16	..	..	15,014·16	6,472·30	..	6,472·30	8,541·86
(8) Grant from Smithsonian Institution for the Secretarial Assistance to Dr. Sálim Ali on the Publication of Handbook of the Birds of India and Pakistan in Ten Volumes ..	12,942·31	..	..	12,942·31	11,883·74	..	11,883·74	1,058·57
Carried forward ..	2,11,643·96	5,216·50		2,16,860·46	21,787·45	..	21,787·45	1,95,073·01

Name of the Fund/Grant (1)	*Balance as per last Balance Sheet* (2)	*Additions/ Amounts received during the year* (3)	*Transfers from other Funds* (4)	*Total of columns 2, 3, & 4* (5)	*Spent/ refunded during the year* (6)	*Transfers to other Funds* (7)	*Total of columns 6 & 7* (8)	*Balance as at 31st December 1972 (5 minus 8)* (9)
Brought forward Rs. ..	2,11,643·96	5,216·50		2,16,860·46	21,787·45		21,787·45	1,95,073·01
(9) Grant from Smithsonian Institution for the Bird Migration Study Survey ..	27,722·99	55,215·00	..	82,937·99	77,906·72	..	77,906·72	5,031·27
(10) Grant from His Majesty King of Bhutan for the publication of 'Birds of Bhutan' by Dr. Sálim Ali ..	11,964·28	649·07	..	12,613·35	1,934·52	..	1,934·52	10,678·83
(11) Grant from Yale School of Forestry for Gir Forest Ecological Research Programme	59,692·47	..	..	59,692·47	59,692·47	..	59,692·47	..
(12) Grant from Smithsonian Institution for Gir Forest Ecological Research Programme ..	11,520·23	3,040·00	..	14,560·23	14,560·23*	..	14,560·23	..
(13) Grant from World Wildlife Fund for the publication on a Booklet on Conservation..	3,024·58	..	..	3,024·58	..	..	..	3,024·58
(14) Grant from World Wildlife Fund Regional Office, Bombay, for Leopard Survey Project ..	..	500·00	..	500·00	500·00	..	500·00	..
(15) Grant from Fauna Preservation Society, London, for Leopard Survey Project ..	..	1,000·00	..	1,000·00	955·49	..	955·49	44·51
Carried forward ..	3,25,568·51	65,620·57	..	3,91,189·08	1,77,336·88	..	1,77,336·88	2,13,852·20

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brought forward Rs. ..	3,25,568·51	65,620·57	..	3,91,189·08	1,77,336·88	..	1,77,336·88	2,13,852·20
(16) Dr. Sálim Ali, Goa Bird Study survey ..	..	3,000·00		3,000·00	3,000·00	..	3,000·00	..
(17) *Grant from Government of Maharashtra :*								
(1) Grant for 1971-72 :								
(*a*) For Establishment expenses ..	9,477·92	..	..	9,477·92	8,937·22 540·70[1]	..	9,477·92	..
(*b*) For Building Maintenance ..	1,996·08	..	..	1,996·08	1,234·35 761·73[1]	..	1,996·08	..
(2) Grant for the year 1972-73 :								
(*a*) For Establishment expenses ..	..	35,764·00	..	35,764·00	27,188·50	..	27,188·50	8,575·50
(*b*) For Building Maintenance ..	..	6,000·00	..	6,000·00	3,675·59	..	3,675·59	2,324·41
(18) Dr. Sálim Ali's 75th Birthday Fund ..	10,866·86	1,718·90	..	12,585·76	..	..	..	12,585·76
(19) Grant from Govt. of India for the purchase of steel cabinets	..	40,000·00	..	40,000·00	2,571·14	..	2,571·14	37,428·86
Total ..	3,47,909·37	1,52,103·47	..	5,00,012·84	2,25,246·11	..	2,25,246·11	2,74,766·73

* Including Rs. 8,860 being ad hoc provision for blocks preparation on Mr. Hodd's article on 'GIR GRASS'.

[1] The relevant amounts being unspent have been refunded to the Government Authorities.

As per our report of even date
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY, 17*th August*, 1973.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the Year ended 31st December 1972

RECEIPTS	Rs. P.	Rs. P.	PAYMENTS	Rs. P.	Rs. P.
To Balance as at 1st January, 1972			By Salary of Nature Education Organiser		7,236·00
National & Grindlays Bank Ltd., Bombay, on Current Account ..		9,377·11	,, Printing and Stationery ..		386·00
			,, General Charges		599·50
,, Grant from Government of Maharashtra for 1971-72		9,236·00	,, Postages		246·25
,, Sales of Nature Study Booklets ..		135·23	,, Balance as at 31st December, 1972 National & Grindlays Bank Ltd., Bombay, on Current Account ..		10,280·59
Total ..		18,748·34	Total ..		18,748·34

As per our report annexed
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY, 17*th August*, 1972.

BOMBAY NATURAL HISTORY SOCIETY

STATEMENT OF INCOME AND EXPENDITURE ACCOUNT

in respect of the publication of Journal for the Year ended 31 *December*, 1972

EXPENDITURE	Rs. P.	INCOME	Rs. P.
To *Establishment Expenses* :		By *Publications* :	
$\frac{1}{3}$, of Salaries including Dearness Allowance, Society's contribution to Staff Provident fund, Postages, Printing and Stationery, Advertisement, Telephone charges, Bank charges, Meeting expenses, Conveyance & travelling expenses etc. etc.	24,522·95	Journal sales	303·72
,, $\frac{1}{3}$ of Audit Fees	333.33	Journal Subscribers	10,790·84
,, *Miscellaneous Expenses* :		,, $\frac{1}{3}$ of Membership Subscriptions	11,017·46
$\frac{1}{3}$ of General charges, Insurance premium, repairs to furniture, Narcondam Hornbill feeding etc.	655·89	,, *Grants* :	
,. $\frac{1}{3}$ of Library expenses, subscription to other Societies, purchase of books and periodicals and book binding charges etc.	693·26	Government of India for the publication of Journal for 1972-73	25,000·00
,, $\frac{1}{3}$ of Maintenance of Reference Collections ..	529·49	Indian National Science Academy, New Delhi, for the publication of Journal for the year 1972-73	3,000·00
,, *Journal Expenses* : ..	55,549·76		
,, Indexes to back volumes of Journals ..	9,360·00		
Total ..	91,644·68	Total ..	50,112·02

As per our report of even date
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY, 17*th August*, 1973.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD AT HORNBILL HOUSE, SHAHID BHAGAT SINGH ROAD, BOMBAY 1, ON FRIDAY, 7TH SEPTEMBER, 1973, AT 6.30 P.M., WITH MR. R. E. HAWKINS, A VICE-PRESIDENT OF THE SOCIETY, IN THE CHAIR.

FORTY-TWO MEMBERS WERE PRESENT

1. In the absence of the President Mr. S. Moolgaokar, Dr. Sálim Ali proposed and Dr. A. N. D. Nanavati seconded that Mr. R. E. Hawkins, a Vice-President of the Society, be elected Chairman of the Meeting. The proposal was accepted.

2. The Chairman asked the Honorary Secretary to present the Annual Report of the Committee.

The Honorary Secretary stated that before he commented on the report, he would like to announce that the Prime Minister of India had agreed to become a Patron of the Society. The announcement was received with acclaim. The Honorary Secretary said that traditionally the Viceroys used to be the Patrons of the Society and Shri C. Rajagopalachari was the last patron as Governor-General of India.

Coming to the Report, the Honorary Secretary said that the trend of membership, if not very satisfactory, was at least positive and there had been a small increase in the membership as the figures indicated. On the date of the meeting he had been informed by the Office that the total membership was in the region of 1250. But this included a number of members who had yet to pay for the current year.

As a result of financial constraints it had been necessary to limit the number of pages of the Journal to around 225 for each issue. As was now the practice with some scientific institutions abroad, a circular letter was sent out to contributors whose articles had been pending for a long period, stating that in the event of their agreeing to pay for the publication cost, their articles would be published within a guaranteed period. The response to this announcement had not been very favourable.

Because of the long delays in bringing out the Journal from the Diocesan Press in Madras, it had been decided to print the forthcoming issue of August 1973 at St. Francis Technical School Press, Borivli, Bombay. It was hoped that by utilising the services of two presses, one in Madras and the other in Bombay, it would be possible to print the Journal without too much delay.

The Honorary Secretary referred to the information in the report relating to our publications and gave the following figures of sale during the past three years.

	1970	1971	1972	
BOOK OF INDIAN BIRDS (8th & 9th Editions) ..	1305	1130	943	copies
BOOK OF INDIAN ANIMALS (3rd Edition) ..	No stock	1015	407	,,
PICTURE POSTCARDS ..	101	165	127	,,
SNAKE CHARTS ..	28	36	122	,,

Regarding Conservation, there was no doubt that there was an increasing awareness about the need to preserve our forests and wild areas, but it was unfortunate that the Maharashtra State Wildlife Advisory Board had not met since 10th of November 1971, in spite of the fact that the statute demanded that the meeting be held twice a year.

Regarding our research activities, the Honorary Secretary said that as a result of the unfortunate differences of opinion between India and the U.S. relating to the use of PL 480 funds, the Society had been put into difficulties, as no funds had been released even for the bird migration scheme. The Government of India, however, had made some ad hoc grants during the past year.

With regard to the financial situation, the Society had made a comprehensive Five Year Plan which had been submitted to the Ministry of Science & Technology. The Plan covered the main activities of the Society namely: Publications, Reference Collections, Bird Banding Scheme and Research in the Field. Recent inquiries in Delhi reveal that there is a reasonable chance of getting substantial funds for these activities.

The Honorary Secretary referred to the information in the section of grants and donations and expressed his gratitude to both Doctors Dillon Ripley and Sálim Ali for the generous grants which had been made.

After these comments from the Honorary Secretary, the Chairman enquired if any members would like to ask questions on the Honorary Secretary's cyclostyled or verbal report.

(1) Mr. Humayun Abdulali and Mr. A. A. Dikshit referred to the resolution passed at the last Annual General Meeting to the effect that a verbal invitation to join the BNHS should be made at all meetings at which non-members were present and said that the Executive Committee had exceeded its powers when it decided instead to display a printed invitation.

The Honorary Secretary admitted he was human and had sometimes forgotten to issue such a verbal invitation. He agreed that the board which was now prominently displayed, with the message ' We need more members, please pick up an application form ', should be regarded as a supplement to a verbal invitation, not a substitute for it.

(2) Mr. Amarnath Dikshit said that there seemed to be some confusion about the membership figures. He said that in the Annual Report for the year 1971 published in the Journal of December 1972, the total membership was mentioned at 1143, while in the Report now presented the membership for 1972 was 1089. How could such a drop in membership be explained? The Honorary Secretary said he would look into the matter and write to Mr. Dikshit.

(3) Mr. Dikshit enquired about the studies carried out by Mr. J. C. Daniel at Kalakkadu and enquired whether the report would be available. The Honorary Secretary said that he would send the report on to the member.

(4) Dr. Deoras asked why the Society had sponsored a bird sanctuary in the Mahim Creek when the area was so polluted, and whether a prior survey had been carried out. The Honorary Secretary replied saying that there were still a very large number of birds that congregated in the area and by making a sanctuary out of the creek, there would be a good possibility of getting the authorities to check the pollution from the neighbouring establishments.

(5) Dr. Deoras complained that the Society in association with World Wildlife Fund-India had held a seminar on ' Conservation—An Answer to Drought ' to which only a few members of the Society were invited. Why was this discrimination made? Mr. Humayun Abdulali also objected to his having been specifically asked not to attend the meeting when he saw the notice of it in the papers and enquired of the Honorary Secretary. Replying to this the Honorary Secretary said that this Conference was held particularly to educate the Legislators of Maharashtra State on good land-use practices, and on the need to maintain forests. No members apart from the Executive Commitee were invited.

(6) Dr. R. N. Vasa asked why the Society's jeep was used for giving lifts to members of the Bird Watchers' Field Club of India and World Wildlife Fund. He also enquired whether it was proper that the Society should spend its funds for assisting members of other clubs.

Replying to this the Honorary Secretary said that all notices sent out to members of associated clubs were paid for by the respective institutions. With regard to petrol expenses of the jeep, on several occasions the World Wildlife Fund had agreed to bear the cost of petrol. He maintained that it was in the interest of the Society to associate all people who were interested in these outings (whether they were members of the Society or not) because one of the objectives of the Society was to arouse interest in natural history.

Mr. Bansi Mehta supported this view and said that we should not allow any factionalism of this kind to grow in the Society.

(7) A member stated that a fee had been charged for admission to the exhibition of snakes organized by Mr. Romulus Whitaker in July and asked whether the Society had received any part of the money collected. The Honorary Treasurer said that, if indeed a fee for admission had been charged, no part of the proceeds had come to the Society. The Chairman undertook to verify whether charges for admission could, consistently with the Society's agreement with the Prince of Wales Museum, be levied by outside bodies which had been given permission to use the Society's premises.

(8) Mr. Humayun Abdulali asked questions relating to the report and the activities of the Society :

(*a*) He asked what research was being done on the pair of Hornbills collected in Narcondam.

Dr. Sálim Ali replied that their growth and plumage changes were being studied by Mr. S. A. Hussain.

(*b*) Mr. Abdulali enquired what advice was given to the Government of India in the preparation of a station for ecological studies at Bharatpur and the Honorary Secretary undertook to send him the letter containing the Society's suggestions.

(*c*) Mr. Abdulali enquired whether the Society had made any recommendations to the Government of India in connection with the Wildlife Protection Act of 1972 which according to him was very defective.

The Honorary Secretary said that the Society had pointed out that the Schedules were defective. The Honorary Secretary also stated that the Act had to be rushed through Parliament on practical grounds and the sponsors were aware that some of the changes suggested (as for example removing Parakeets from the Vermin list for sentimental reasons) was unfortunate, but had been aceepted with a view to avoiding further delays.

(*d*) Mr. Abdulali asked whether the grant of Rs. 10,000 received from Dr. S. D. Ripley for field work was earmarked for any particular purpose, and on being informed that it was a contribution towards the expenses of field work in Bhutan, asked why the specimens already collected in Bhutan had not been added to the Society's Reference Collections and whether all specimens collected in future would come to the Society's Reference Collections. He considered that, before any such expedition set out, the way in which specimens collected were to be disposed of should be clearly defined. Dr. Sálim Ali (at the Chairman's invitation) replied that the specimens collected in Bhutan were still being worked on and only some of the duplicates may be given to the Smithsonian Institution.

(*e*) Mr. Abdulali and Mr. Amarnath Dikshit enquired whether the Sanctuary designated to perpetuate the memory of Fr. Santapau at Khandala was adequately protected and what its status was, and where it was located.

The Honorary Secretary said that he was informed by the Forest Department that the area was already part of a Reserve Forest and full protection was being provided. For the moment therefore all that remained to be done was that a board naming it as the Fr. Santapau Sanctuary would have to be put up. The Area selected was one where Fr. Santapau and his students had done a lot of work.

There being no further comments Dr. C. V. Kulkarni proposed the acceptance of the Report, Mr. G. V. Bedekar seconded, and the Chairman declared the Report adopted. He then called upon the Honorary Treasurer to present the Balance Sheet and Statement of Accounts for the past year.

A member deplored the small amount spent on books for the library.

After several other questions had been asked and answered by the Honorary Treasurer the Statement of Accounts was adopted, having been proposed by Dr. A. N. D. Nanavati and seconded by Professor P. V. Bole.

3. The Chairman said that the following nominations were deemed to be approved :

President :

Dr. Sálim Ali

Vice-Presidents :

Mr. R. E. Hawkins
Mr. G. V. Bedekar, I.C.S. (Retd.), J.P.

Honorary Secretary :

Mr. Zafar Futehally

Honorary Treasurer :

Mr. J. D. Kapadia, I.C.S. (Retd.)

Advisory Committee :

Mr. H. G. Acharya	*Ahmedabad*
Mrs. Jamal Ara	*Ranchi*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Mr. S. Chaudhuri	*Calcutta*
Dr. Chintaman Deshmukh, I.C.S. (Retd.)	*Hyderabad*
Dr. A. P. Kapur	*Calcutta*
Mr. Shivrajkumar Khachar	*Jasdan*
Mr. M. Krishnan	*Madras*
Mr. Duleep Matthai	*New Delhi*
Mr. Ranjit Sinh, I.A.S.	*New Delhi*

Mr. Humayun Abdulali rose to a point of order maintaining it was improper to re-appoint as Honorary Secretary a person whose conduct was the subject of an enquiry committee and who did not attend to the correspondence of the Society as required by the Rules. He was overruled by the Chairman, who pointed out that the Society could not function efficiently for the six weeks necessary to hold an election without the services of a duly appointed Honorary Secretary and Honorary Treasurer.

With regard to the Executive Committee, the Chairman stated that apart from the nominations of the Executive Committee, four other nominations had been received, namely :

Mr. Humayun Abdulali proposed by Dr. P. J. Deoras seconded by Mr. A. A. Dikshit.

Dr. P. J. Deoras proposed by Dr. R. N. Vasa seconded by Mr. A. A. Dikshit.

Mr. Amarnath A. Dikshit proposed by Dr. R. N. Vasa seconded by Mr. Humayun Abdulali.

Dr. R. N. Vasa proposed by Mr. A. A. Dikshit seconded by Mr. Humayun Abdulali.

It would therefore be necessary to hold a postal ballot as provided for in Rules 32 and 33.

4. Mr. Humayun Abdulali had given notice that he would be moving the following resolution :

That the report of the Sub-Committee appointed by the Executive Committee to consider the proposals made by Dr. P. J. Deoras at the last Annual General Meeting be published and circulated to members of the Bombay Natural History Society.

On the Chairman's assurance that, at a meeting of the Executive Committee held a few hours earlier, it had been decided that, when the sub-committee's full report had been received and considered by the

Executive Committee, it would be made available to members at the Society's premises, Mr. Abdulali withdrew his resolution.

The meeting terminated at 8 p.m. with a vote of thanks to the Chair.

In the postal ballot held in October 1973 the following were elected to the Executive Committee :

EXECUTIVE COMMITTEE

Mr. Humayun Abdulali
Dr. S. R. Amladi, M.D.
Prof. P. V. Bole
Dr. E. B. Fanibunda, F.D.S.R.C.S. (Eng.), F.R.P.S.
Dr. C. V. Kulkarni, M.SC. Ph.D.
Dr. A. N. D. Nanavati, M.D.
Mr. D. J. Panday
Mr. B. B. Paymaster, I.C.S. (Retd.)
Mr. G. S. Ranganathan
Mr. D. E. Reuben, I.C.S. (Retd.)

ERRATA

Volume 69(3) : December 1972

Miscellaneous Note No. 23—The habitat and distribution of *Psilotum nudum* in South India.

On Page 682, para 1, line 5

for ' The labels of ' *read* ' The labels on '

para 1, line 6

for ' herbarium sheets of specimens from Kartikeyan (M.H. No. 26863, Sebastine, K.M. & M.H. No. 3945, 12965)', *read* ' herbarium sheets of Kartikeyan (M.H. No. 26863), and Sebastine, K. M. (M.H. No. 3945, 12965) '.

para 1, line 9

for ' Hydnacarpus ' *read* ' Hydnocarpus '.

para 1, line 10

for ' (on rocks) ' *read* ' on rocks '.

On Page 682, insert

Dept. of Botany,
Jawahar Bharati,
Kavali, (A.P.) 524202,
November 23, 1971.

REFERENCES

Prain, D. (1894) : The genus *Psilotum* Sw. in India. *J. Bombay nat. Hist. Soc.* **8** : 428.

Raizada, M. B. (1935) : The genus *Psilotum* Sw. in India. *Indian Forester* **61** : 654-658.

Venkateswarlu, V. (1943) : On the occurrence of *Psilotum triquetrum* Sw. in the East Godavari District. *Sci. Cult.* 9(4) : 165.

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EDITORS: ZAFAR FUTEHALLY, J. C. DANIEL & P. V. BOLE

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. 3rd (revised) edition 2 plates in colour by Paul Barruel and many other monochrome illustrations. *(Price to members Rs.* 35)	Rs. 40
The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett	Rs. 10

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The Society will gratefully accept back numbers of the *Journal,* from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 (25*p.*) and a life membership fee of Rs. 600 (Inland), £45·50 (Foreign).

Ordinary Members pay an entrance fee of Rs. 5 (25*p.*) and an annual subscription of Rs. 36 (Inland), £3 (Foreign).

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £3·00 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 23 Fenchurch Street, London E.C. 3.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

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